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ABSTRACT

The major objective of the 32 activities in this teaching guide is to make students aware of energy issues. Although the activities are designed for students in grades 4-12, they can be adapted for younger students and for adults. Departing from the standard expository approaches found in most curriculum materials, these teaching strategies include starter exercises to spur interest in and discussion of topics on energy, data gathering, and using community resources. The first of the six sections contains activities for identifying student attitudes about energy issues. Section two provides activities for teaching vocabulary, map reading, comparison/contrast skills, interdependence concepts, and math skills pertaining to energy topics. Presenting data for studying energy issues is the goal of section three. Activities focus on teaching students how much energy appliances use and alternatives to this kind of energy use. In section four, students are asked to think about what may happen with energy in the future, what people could do to affect energy in the future, and what ideas students would place in an energy platform. The fifth section provides activities for demonstrating, creating, and displaying ideas for energy alternatives. Examples of these special activities are to have students design a T-shirt with a picture of energy, build a solar hot dog cooker, and conduct a poster contest. Each activity contains an introduction; a list of objectives; and information about grade level, time required, and materials needed. The general teaching procedure has a basic skills focus. Often there is a debriefing and question section. The last section contains handouts. (Author/NE).

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TEACHING ENERGY AWARENESS

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INTRODUCTION

This volume contains a wide variety of supplementary teaching activities designed to complement existing curricula related to energy and environmental issues. It is not intended to be used as a text or self-contained unit. The main goal of these activities is to create student interest in and awareness of energy issues by presenting activities that approach energy topics with a variety of teaching strategies.

Topics

Teaching Energy Awareness is divided into five sections. Section I, "Developing Student Awareness," contains activities for finding students' awareness of and attitudes toward energy issues. Section II, "Teaching Basic Skills," provides twelve activities for teaching vocabulary, map reading, comparison/contrast skills, interdependence concepts, and math skills pertaining to energy topics.

Section III, "Teaching Energy Facts," presents data for studying energy issues. Activities in this section focus on teaching students how much energy appliances use and what some of the alternatives to such energy use are. Section IV, "Anticipating the Future," presents four activities for getting students to think about what may happen with energy in the future, what people could do to affect energy in the future, and what sorts of ideas students would place in an energy platform. The final section, "Special Activities," provides five activities for demonstrating, creating, and displaying ideas for energy alternatives.

Teaching Strategies

These activities depart from the standard expository didactic approaches found in most curriculum materials. Whenever possible, students are presented with the opportunity to involve themselves in the energy issue. Moreover, the variety of strategies employed departs from the "read and recite" format of many materials on the market.

Many activities employ discussion as their primary teaching strategy. However, instead of simply giving students a topic or an issue to discuss, the lessons provide an activity or starter exercise to spur interest in the topic or issue. Then, discussion can proceed with more enthusiasm. Other teaching strategies used are data gathering and using community resources.

When and Where to Use the Activities

These activities are designed to be used with upper elementary, junior high, and senior high school students, as well as with adult audiences. Each activity is labeled with an appropriate grade level. However, most of the activities can be adapted for use with younger students.

In the school curriculum, these activities are appropriate supplementary materials in any course of study that deals with energy and/or environmental issues. Specifically, they can be used in social studies, science, home economics, government, economics, and world affairs classes.

Evaluation

These materials have been used with success by teachers in many school systems. It is our intention to continue revising and adding to the materials whenever time permits. Accordingly, we have included an evaluation sheet at the end of the book. We encourage you to use the activities which you think are most appropriate to serve your needs, fill out the evaluation form, and send it to us for our information. Your input will be greatly appreciated.

Revised, August 1980

DEVELOPING STUDENT AWARENESS

Title: ENERGY AWARENESS QUIZ

Introduction: A pre-and/or posttest to determine students' awareness of critical energy issues. The quiz used in this activity can provide basic information about students' backgrounds in energy. You might consider using it in a pretest and posttest format.

Objective:

To examine students' awareness of major components of the energy crisis.

Grade Level: 7-12

Time: One hour

Materials: Handout #1, "Energy Awareness Quiz."

Procedure:

Step 1. Distribute one copy of the handout to each student.

Step 2. Have students take quiz. They can circle the answers they select.

Step 3. Debrief with the questions below. Be sure to give students the correct answers.

Step 4. Have students gather data to substantiate their answers to the following questions. This could be used as a research project for the class. If appropriate, group students and assign each group one topic to research.

Debriefing:

1. Are there answers that students disagree with?
2. Are there answers that surprise the class?
3. What, if any, changes would students consider making in their consumption habits after doing this activity?

4. What statements can students make about U.S. consumption as compared with other countries?

5. Which energy topics would students like to find out more about?

Gary R. Smith

ANSWERS TO THE ENERGY AWARENESS QUIZ

1. c. Over 20 hours. It takes 2.25 KWH to manufacture an aluminum can, so the exact answer is 22.5 hours.

2. Over 90 percent of the energy in the gas line from crude petroleum is lost in making your car move. The efficiencies of the most important steps where energy is lost are:
   producing the crude oil--96 percent
   refining--87 percent
   gasoline transportation--97 percent
   engine efficiency--29 percent
   rolling efficiency--30 percent
   To get the total efficiency of the system, we multiply the six factors together, and get 7 percent.

3. Similar to the problem above, there are losses when the coal is burned in the power plant to produce electricity; there are losses in transmitting the electricity to your home, and there are losses in getting the coal from the ground to the power plant. The answer to this question is (a) 1/3.

4. a. 10 percent. The biggest users in our homes are air conditioners, electric water heaters, and electric space heating. Refrigerators and freezers are fairly large users also. The many gadgets that we have are not such big users, but they take energy to make them.

5. c. 30 percent. If there were a village of 100 people and only six of them were using resources which could be used for thirty, how long do you think that situation would be permitted to exist?

6. c. 100 times more.

7. Riding a bicycle. The reason is that the gears and pedals give you much more "pull" for the amount of energy you are expending.

8. c. 1,000,000 years

9. c. 1 percent. Most solar energy doesn't even get through the atmosphere. It is reflected. The little which does come through can be used to produce food energy in plants only in certain wave lengths.

10. c. about fifteen times

11. c. 98 percent

12. b. 1/2 ton of coal.

13. False. Labor intensive farming produces just as much per acre as machine intensive farming. Our acre yield increases have come about mostly as a result of hybrid crops and increased fertilization.

14. a. 3 percent

15. c. Ten times the amount. This includes the petroleum used in the tractor which plowed the field to grow the food and harvest the crop. It includes the pesticides and fertilizers which are petroleum based, the transportation to the processor, the energy used in processing, and the transportation to the store.

16. c. 1,500

17. c. Over five times as much as population growth. Each person, therefore, was using more electricity.

18. c. 17 billion gallons.

19. c. 40%. This includes six inches of insulation in the roof, three inches in the walls, storm windows, and window and door weatherstripping.

20. b. 10 percent

Title: ENERGY RIGHTS CONTINUUM

Introduction: Americans are the greatest consumers of energy. We consume more than half of the world's energy. Do we have a responsibility toward the rest of the world's people? This activity gives students a chance to think about the "rights" we have as energy consumers.

Objectives:

To give students a chance to evaluate their rights as compared to others.

To let students examine the consequences of the "rights" they want to have.

Grade Level: 7-12

Time: One hour

Materials: Handout #2, "Rights."

Procedure:

Step 1: Have the students stand in a single line along the length of the classroom. Designate one end of the line as being for the students who are in favor of all Americans having a certain right. The other end of the line is for students who are opposed to all Americans having that right. The middle areas of the line are for students who are somewhere in between. Read one of the rights from the handout and ask the students to arrange themselves in the line according to the degree of their support for or opposition to the right. Ask some of the students from each end and from the middle to give reasons for the position they took. Repeat the procedure with several other rights from the list, trying to get a variety of positions.

Step 2: Distribute one copy of the handout to each student. Have the students return to their seats.

Step 3: Have students individually circle the number of those rights they want to have.

Step 4: Share students' selections and choose five "rights" they most value.

Debriefing:

1. Can students have all the rights? Are there contradictions among the rights?
2. Are there other rights related to energy students would like to include?
3. Would an environmentalist answer the same way that students did?
4. Do students feel that they can currently enjoy those five rights they most value? Are there obstacles to having them? Do students feel that they will be able to enjoy the same rights five years from now? What problems, if any, do they foresee?
5. What role does the government have in guaranteeing that we have these rights?
6. Are there pressure groups that influence what rights we have available to us?
7. Who determines what rights we will be able to enjoy?
8. Are there some rights that people should give up voluntarily without legal enforcement? Will people voluntarily give up their rights?

Patricia A. Heist

Title: QUALITY OF LIFE SURVEY

Introduction: People's satisfaction or dissatisfaction with their quality of life will affect the demands they make on the world's natural resources as they try to maintain their quality of life or improve it. This activity gives the students a chance to compare their quality of life with others in the U.S. and the world.

Objectives:

To compare levels of satisfaction or dissatisfaction with important aspects of one's life for several different groups of people.

To generate hypotheses about these levels of satisfaction and the demands on the natural resources.

Grade Level: 4-12

Time: One class period

Materials: Handout #3, "Quality of Life Survey."
Handout #4, "Results of Quality of Life Survey," conducted by Gallup International Research Institutes.
Transparency of the results

Procedure:

Step 1: Pass out the "Quality of Life Survey" (Handout #3). Have students fill out survey as they interpret the categories.

Step 2: Have students speculate as to the order from highest to lowest for each population group in each category. Do this for the U.S. first, then the world. With each speculation, reveal only that result on the overhead projector.

Step 3: Distribute Handout #4.

Questions:

1. What kinds of pressure will the dissatisfied peoples of the world place on the natural resources?

2. Who determines the standard for highly satisfied?

3. How can the image of the quality life be changed in the U.S.? The world?

Title: ENERGY ATTITUDE SURVEY

Introduction: This activity allows students to express their views and opinions on the energy situation. It can be used as a classroom or schoolwide poll.

Objective:

To determine students attitudes on the energy situation.

Grade Level: 6-12

Time: One hour

Materials: Handout #5, "Energy Attitude Survey"
"Energy Attitude Talley" (optional)

Procedure:

Step 1: Distribute one copy of the handout to each student. Ask students to fill out the handout individually.

Step 2: Take a class survey and tabulate the individual responses to the handout.

Step 3: After teaching a unit on energy, give the survey as a posttest.

Question:

1. Are there any ambiguities in the survey?
2. What additional questions could be asked in the survey?
3. Were there any questions which were dated, inappropriate, or slanted toward a particular direction of conservation?

Suggestions:

1. Print the results of the survey in the school newspaper.
2. Survey adults. Do their opinions differ much from the students?

3. Handout Energy Attitude Tally and have students calculate percentages of class response.

Pat Gore and John Masoncup

Title: NUTS GAME

Introduction: The nuts game is a simulation of competitive harvesting of a renewable resource.

Objective:

To illustrate the "tragedy of the commons."

To increase student awareness of problems associated with voluntary conservation.

Time: Forty-five to sixty minutes

Grade Level: 4-12

Materials: Large container of pennies
M&M's or peanuts (200-300 per group)
A large empty bowl for each group

Procedure:

Step 1: Divide the class into groups of six. Place ten M&M's in a bowl for each group. Each group is instructed that the object of the game is for each person to get as many M&M's as he can. Any student who moves the bowl or gets rough loses his M&M's. Each person may take as many as he wants any time he wants during a fifteen second interval. The students are not allowed to discuss any plans of what they are going to do. At the end of fifteen seconds have each student record how many M&M's they got. Refill the bowl and play again. Repeat for three rounds.

Step 2: Play the game for another round but with this change in rules: At the end of the fifteen-second interval the number of M&M's remaining in the bowl will be doubled and the students will harvest M&M's for another fifteen-second interval. The process of doubling and harvesting will continue until the bowl is empty. Again no talking is allowed.

Step 3: Play the game as in Step 2 again, but this time allow the groups 5-10 minutes to make a plan to maximize the number of M&M's each person will get.

Step 4: If no groups succeed in harvesting the M&M's slowly enough to get several doublings, tell the students that the best strategy is to wait while the M&M's double a few times and then harvest slowly in turns. Appeal to them to conserve voluntarily for the good of the group. Start with ten M&M's and play the game again.

Variations in Procedure:

It is recommended that this game be used early in the energy unit as an introductory activity. If the game is played after too much discussion of the "tragedy of commons," students may see through the game too early.

If it seems likely that the students are anticipating the outcome, announce in Step 2 that the game will continue until the bowl is empty or until the teacher (who is in control of the M&M cartel) arbitrarily and unannounced ends the game after an arbitrary number of fifteen-second intervals.

The game can also be played in groups of four seated back to back and facing in opposite directions. No talking is allowed and students must face straight ahead without seeing what the others are doing. The bowl of M&M's is passed silently around the group and each person takes as many as she wants. This variation might be useful if the students would be too inhibited about appearing "grabby" in front of the others. Each person does not know what the others are doing and can be greedy without being observed.

Questions:

If everyone agreed to let the M&M's double and then take a little bit at a time, the group could harvest M&M's forever and each person would get plenty. Why doesn't it always work out this way? During Step 3 each group had to create a method to get members to conserve. Was it voluntary or compulsory? Which method worked better? Were there "free riders" in the group? How did group members feel about "free riders?" Were you worried what others in the group would think about the number of M&M's you took?" Did this prevent you from taking as many as you wanted?

From Psychology Today, August 1979, "Free Riders in Route to Disaster" by Julian Edney.

Title: POSITIVE INCENTIVES TO CONSERVE

Introduction: One of the big problems with getting people to conserve energy is that the individual usually receives more benefit from using energy than from conserving energy. Lack of effective immediate feedback is also a problem because many efforts to conserve will not have immediately observable or tangible effects. Thus, a family who turns the thermostat down may not know the results until they get next month's heating bill which may or may not be lower. When available, this feedback information can itself become a reinforcer or reward for conserving.

Objectives:

To brainstorm plans for position incentives for conserving energy.

To increase student awareness of what motivates people to conserve.

Grade Level: 4-12

Time: One hour

Materials: A list of situations or opportunities for energy conservation
Large sheets of paper and felt tip markers

Procedure:

Step 1: Ask introductory questions about situations in which students do or do not conserve. Do you walk to school? Do you car pool? Do you hang clothes on the line or use a dryer? Do you close doors and turn off lights? Do you ride the bus? Why do people sometimes conserve and sometimes fail to conserve energy?

Step 2: Organize students in groups of four to six students each. Give each group a list of situations where energy can be conserved. Ask each group to select three of the situations on the list and brainstorm methods for providing positive incentives and feedback for conserving energy in each situation. During the brainstorming process, the goal is not to evaluate the plans for practical considerations but rather to propose a variety of solutions to the problems. Each group will write their ideas for positive incentives on the large sheets of paper so that they can be viewed at a distance by the large group.

Step 3: After the students have listed a variety of methods for providing positive incentives and feedback, ask the groups to select the methods they think will work the best.

Step 4: Reassemble the small groups into a large group. Have a spokesperson from each group present the situations the group selected and the positive incentives that were suggested.

Suggested Discussion Questions:

1. Do you think the suggested incentives would encourage people to conserve?
2. Is the plan practical and economical?
3. Does the plan provide feedback information so that people will know if their efforts are successful?
4. Does the plan rely mostly on penalties for failure to conserve or rewards for success?
5. Can you think of incentive plans for other situations where people need to conserve?

Pat Gore and John Masoncup

TEACHING BASIC SKILLS

Title: ENERGY PASSWORD

Introduction: The game "Password" has been popular for many years. One of the convenient features of the game is that once consumed, players could pick up a dictionary and add words to make up new playing cards. This activity simply suggests using words related to energy and environment for add-on cards players can make up.

Objectives:

To play the game "Password" using energy-related terms.

To build vocabulary regarding energy and energy-related issues.

Grade Level: 4-12

Time: One hour minimum

Materials: Copy of Password game which can be purchased at most department or drug stores. The game is manufactured by Milton-Bradley, Springfield, Massachusetts.
Handout #6, "Suggested List of Words for Playing Energy Password."

Basic Skills Focus: A. Game playing
B. Vocabulary building

Procedure:

Follow regular Password rules using new cards made up with energy-related terms.

Gary R. Smith

Title: LOOKING BACK

Introduction: Historical comparisons using old and new "Sears Catalogs" are developed in this activity. A case can be made that our own values are reflected through advertisements. Using catalogs as a data base, students will discover that advertisements can be a "time line" showing our ever-increasing rates of energy consumption. By manipulating old and new advertisements, students will identify sources of energy and how, indeed, they have changed.

Objectives:

To articulate a sense of the historical development of energy consumption.

To compare and contrast data.

To distinguish between "task" and "method of operation."

To compute amount of energy needed to operate household appliances.

To identify types of energy.

To articulate about cultural values.

To categorize data.

Grade Level: 5-12

Time: Variable, two-three class periods

Materials: Teacher information, "Looking Back"
Handout #7, 1897 advertisements*
Handout #8, present day advertisements*
Calculators
"Sears Catalogs" (teachers can usually obtain several by phoning any Sears store)

---

*Masters for some of the pictures are behind Handouts #7 and #8. Make additional ones.

Procedure: This activity can be used in a variety of formats:

Option A. Historical Comparisons: Divide students into groups of five and six. Distribute a sample of Handout #7 and Handout #8 to each group.

Given the new appliances/gadgets, what item(s) from the "Sears Catalog 1897" performed the same task? What kinds of energy were needed to operate these appliances? How are they different? How have our patterns of energy consumption changed since the turn of the century?

Option B. Categorizing: Divide class into two groups, distributing Handout #7 to one group and Handout #8 to the second group of students.

Given this data, form categories in this activity. Possible responses:

Types of Appliances
- Kitchen
- Entertainment
- Grooming
- Health

What do your categories tell us about ourselves? Is quickly fixing meals important to us? Leisure time? Outward appearances? What comparisons can be drawn between the 1978 advertisements and those of 1897?

Option C. Data Manipulation: Similar to the activity, "Energy Using Gadgets," post pictures of appliances around the room

Students should walk around the room identifying each appliance on their papers. Then they should check each of the appliances that are in their own homes. What appliances do they have at home that are not included in the pictures?

Using the following formula, students can determine actual amounts of energy consumption in their homes:

Example: Electric coffee pot used 1/2 hour per day:

$$\frac{\text{15 hrs./month} \times \text{890 watts}}{\text{1,000}} = \text{13.4 kwh/month}$$

Watts per appliance are included in Handout #7 and Handout #8 at the end of this activity. The Sears Catalog can also be used as a resource.

Compare energy consumption between appliances of 1897 and those found in their own homes. Are there any appliances from Handout #7 in students' homes?

Option D. Cultural Values: The handouts can also be used to determine what is important to us. Working in small groups, students prioritize the data.

Using Handout #8, ask students to select the ten most important items to them today. Try to reach a group consensus. Discuss why the items were chosen. What would the person of 1897 choose from Handout #7? How would responses differ?

Another indicator of our values is how we spend our money. Students can play a "Price is Right" game, guessing the price of each appliance. Prices are included in the handouts, or students can use catalogs to search for actual prices of each appliance.

Students can also design a "Good News, Bad News" activity. Write the words "Good News" on one half of the blackboard and "Bad News" on the other half. Using Handout #8, or by collecting their own pictures, students can assign appliances to the appropriate column on the board. They will categorize the data based on their own knowledge of energy consumption, assigning a "good" or "bad" value to each item. Probe students to articulate the criteria used in reaching their decisions. Is the appliance seen as good or bad news to us? To the world?

Jacquelyn S. Johnson

Title: OBSERVING ADS

Introduction: We sometimes get conflicting messages from advertisers about products which consume energy. On one hand, new products are put on the market which represent "improvements" of older products because they are more efficient and save energy. Yet, the number of items being introduced which consume more energy (in the aggregate) are numerous. In this activity, students look at various advertisements to become aware of how consumers are sold more products that consume energy.

Objectives:

To compare advertisements of companies which promote energy-using products.

To recognize the persuasiveness of advertising in getting people to consume energy.

Grade Level: 7-12

Time: Two to three hours

Materials: Magazines and newspapers, scissors
Handout #9, "Observation Sheet"

Basic Skills Focus: A. Data collection
B. Data interpretation
C. Comparisons

Procedure:

Step 1. Distribute a copy of the handout to each student.

Step 2. Ask students to collect the information requested on the handout from magazines, newspapers, TV, etc.

Step 3. Categorize ads as illustrations of "savers" or "spenders."

Gary R. Smith

Debriefing:

1. In students' opinions, are we being asked to save energy or expend energy based on the advertisements they look at?

2. How would students change the advertisements to help conserve energy?

3. Do new products promote spending or saving energy?

4. How many ads actually mention saving or conserving energy? Would those ads have appeared in the media ten years ago? Are they only responding to recent energy consciousness of consumers?

5. Is the promotion of "saving" and "spending" related to the source of energy?

Title: ENERGY ADS

Introduction: A great deal of advertising has been given impetus by the energy crisis. Ten years ago the advertisements on the accompanying handouts would not have been in print. This activity asks students to look at a series of ads to analyze some of the basic techniques employed.

Objective:

To deduce and list some of the basic issues that are addressed in energy advertising.

Grade Level: 4-12

Time: One and one-half hours

Materials: Ads collected from magazines and newspapers

Procedure:

Step 1: Divide class into three groups of students.

Step 2: Distribute five ads to each group so that each group has different ads.

Step 3: Ask each group to concentrate on the following questions:

(a) What solutions to the energy crisis are suggested in the ads?

(b) Are consumers being asked to consume rather than to save?

(c) Why would oil companies and utility companies wish to advertise for conservation when their main interest is in selling products?

(d) What new companies might be started as a result of the energy issue?

Gary R. Smith and Patricia A. Heist

Step 4: Categorize ads in the following categories (some ads can be put in more than one category):

(a) conservation

(b) energy alternatives

(c) types of industry or company

(d) types of energy

(e) any other categories students can brainstorm

Step 5: Discuss what specific products are being advertised to saver energy.

Step 6: Looking at the advertisements, can students see a reason for gasoline, coal, and other energy-related prices to increase in recent years?

Title: MAPPING ENERGY

Introduction: Besides utilizing map skills, this activity suggests some ways to illustrate the sources, consumption, and development of energy on a map. The basic data sources can be found in the library. You may have to provide assistance to students in finding those sources.

Objective:

To use the blank maps to illustrate consumption, sources, and development patterns of energy.

Grade Level: 7-12

Time: Varies

Materials: Handout #10, Blank World Map
Handout #11, "Map Suggestions"
City map
Telephone Yellow Pages

Basic Skills Focus: A. Reading maps

B. Interpreting data

Procedure:

Step 1: Divide students into groups of three to four.

Step 2: Using the library, telephone, pamphlets, and whatever additional data sources you and your students can collect, ask each group to do at least two of the suggestions using the maps. (Each suggestion will probably take one map.)

Step 3: Pass out city maps and do the same activity but with a local emphasis.

Step 4: Arrange to visit some energy sources locally. Look in the Yellow Pages for sources.

Gary R. Smith

Title: MAP DIRECTORY OF RENEWABLE RESOURCES

Introduction: The North American maps contained in the following handouts locate the major areas and patterns of our renewable energy resources. The information can tell us where we might consider moving if we were interested in utilizing those resources. They tell us, generally, what renewable resources are most feasible to use in our own area and they suggest that we look more deeply into a more accurate pinpointing of useable resources in our own locales.

Objectives:

To familiarize students with the major locations and patterns of sunshine, wind speed, water, hot springs, wood, and fossil resources (coal, gas, and oil).

To stimulate research into feasible renewable resources for use in students' local communities.

Grade Level: 4-12

Time: One hour

Materials: Handouts #12-#18, "Maps of Renewable Resources"
(Source: Place, Vol 1, No. 2, pp. 105-125, 1972)

Procedure:

Step 1: Distribute the maps to each student.

Step 2: Ask students to determine how practical solar power would be for use in their homes. (They will, of course, need to look further than the map. For one thing, the map only denotes general areas of sunshine. Moreover, their roofs would need a southern exposure, unencumbered by trees or anything else that would provide shade. Also, their homes would probably need more insulation than they presently have.)

Step 3: Ask students to determine how practical wind power could be for their community.

Gary R. Smith

Water power? (Are power companies possibly consuming more fossil fuels in making electricity than they would if there were better use made of hydroelectric power?)

Geothermal power? (Where is the nearest hot spring? Could it be used for power?)

Wood?

Fossil Resources? (Chances are, these are already being taxed to the limit.)

Title: HOW THINGS CONNECT

Introduction: A graphic way of illustrating the degree of interdependence among energy problems is to have students locate points of origin for current energy news items on a world map, and then locate other places on the map where those same news items will have economic, political, and social consequences. By drawing lines between the various points, students should be able to recognize the extent of interdependence between energy issues and problems.

Objectives:

To recognize the extent to which news items related to energy, many of which appear strictly local or national in scope at first sight, have global implications and consequences.

To brainstorm ways in which energy issues are related on a global basis.

Grade Level: 7-12

Time: Forty-five minutes

Materials: Large wall map of the world. This item can be purchased at bookstores, office supply stores, and map stores for $1.00 to $2.00 each. (Note: If possible, purchase two or three world maps, each a diferent projection, e.g., Mercator, Dymaxion, Polar, equal-area projection, etc. This would add an important dimension to the activity because it exposes students to different views of this world, and the connecting lines they draw will show a different perspective.)

Basic Skills Focus: A. Map reading (interpretation)

B. Building and using concepts (interdependence)

Procedure: (Teacher preparation: Tape up wall map.)

Gary R. Smith

Step 1: Divide class into groups of five to six students per group.

Step 2: Give each group four to five newspapers.

Step 3: Ask students to cut out all the news articles they can find related to energy. Allow about ten mintues for this step.

Step 4: Ask one member of each group to collect all the clipped articles. Ask those same students to bring the clippings to the wall map.

Step 5: Have those same students place a dot or mark on the map indicating where the news article originated. For example, if the article is about a blackoutin New York City, the students should place the dot on New York City. If the article is about an agreement made in Tunis among the OPEC nations regarding selling oil to the United States, place the dot in Tunis. (Note: Encourage help from each student's group with locating the origin of the articles. Reassure students that this is not a test of how well they know geography. This step should be carried out with help from the whole class, including your input.)

Step 6: Ask another member of the same groups to come to the map. As a class, students need to brainstorm the following: Where else in the world would the news item have an effect? As these places are stated, the student at the map should place a dot on the location. The places could be cities, countries, regions, or geographical areas.

Step 7: Ask another person from the groups to come up to the map. This student's job is to draw lines connecting the dots for each news article using a yardstick. For example, if the news item is about development of a number of power plants in South Africa and students have decided that the item could have consequences in the United States and the USSR, then the student should draw a line connecting the dots between South Africa and the United States and a second line connecting the dots between South Africa and the USSR.

Step 8: Proceed to follow the same procedure as outlined in Steps 4-7 above for the remainder of the groups in the class, or until you and your students get tired of the activity.

Debriefing

1. This activity usually ends with a map full of lines. Hence, it graphically illustrates the interdependence of energy issues. Ask **students** if the map became cluttered with lines and what they may mean.

2. What things about how energy issues and problems are interconnected did students learn from this activity? (Possible responses: energy news items have geographical implications far beyond their points of origin; there is a much greater degree of interrelatedness between places and events than people ordinarily realize; decisions in one part of the world are dependent upon and have impact on peoples and resources in other parts of the world; items ordinarily considered as local or national in scope often have international dimensions.)

Title: ONE THING LEADS TO ANOTHER

Introduction: Interdependence is a concept fundamental to the understanding of energy problems. As indicated in other activities in this volume, "things ramify," they have consequences. This simple exercise asks students to draw lines betwen phrases that are in some way related to energy and environmental concerns.

Objectives:

To recognize the interconnections of energy and environmental problems and issues.

To diagram how these issues interconnect.

Grade Level: 6-12

Time: One class period

Materials: Handout #19, #Interconnections"
Handout #20, "Future Wheel"

Basic Skills Focus: A. Values clarification
B. Reading and interpreting graphs

Procedure:

Step 1: Distribute a copy of "Interconnections" to each student.

Step 2: Students may draw lines or arrows connecting the various phrases. The idea is to show, by use of the lines and arrows, how one problem, concern, issue, or phenomenon leads to another.

Step 3: Ask students to volunteer to hold up their diagrams and explain how they come up with their lines (arrows) and diagrams. In other words, how did students create the diagrams?

Step 4: Distribute copies of "Future Wheel" to students. Ask students to discuss and compare their drawings with the future wheel.

Gary R. Smith

Title: PROBLEMS, PROBLEMS

Introduction: In the process of becoming consciously aware of energy issues, students need some exposure to the dynamics of how problems and solutions are interrelated. Many times people see solutions but fail to realize the consequences of those solutions. When a solution is proposed and implemented to meet a problem, new problems may arise from the solution itself. This activity asks students to think about possible consequences when turning to solutions to meet technological problems.

Objectives:

To recognize how technological solutions can have consequences.

To recognize that a solution may not be an answer.

To recognize the principle of interdependence.

Grade Level: 7-12

Time: Forty-five minutes

Materials: Handout #21, "Consequences"

Procedure:

Step 1: Have students list problems that are connected with energy.

Step 2: Distribute copies of the handout to students.

Step 3: Divide students into groups to discuss possible solutions and consequences. Have the groups fill in the chart.

Debriefing

1. For which problems were students able to find solutions?
2. Would there be any difficulty in carrying out those solutions?
3. Are the consequences worth the solution?

4. Were there problems which had no apparent solution?

5. Did everyone in your group agree on problems and/or solutions?

Gary R. Smith

Title: ENERGY AND ENERGY CONVERSIONS

Introduction: This activity provides some background information about energy and its conversion from one form to another.

Objectives:

To recognize several simple devices which convert energy from one form to another.

To determine the efficiency of these devices by the use of a table.

Grade Level: 9-12

Time: One hour

Materials: Handout #22, "What is Energy"
Handout #23, "Worksheet #1"
Handout #24, "Worksheet #2"

Procedure:

Step 1. Distribute the "What is Energy" article and have students read it.

Step 2. Distribute Worksheet "1. Have students fill in the chart as well as they can with devices that convert one form of energy to another form.

Step 3. Distribute Worksheet #2. Have students fill in the worksheet with the listed efficiencies.

Questions:

1. What changes in energy form are the most efficient?

2. What changes in energy form are the least efficient?

Pat Gore and John Masoncup

Title: RESOURCE DEPLETION

Introduction: No natural resource is consumed at a constant rate. An understanding of resource depletion curves is crucial to an understanding of our nonrenewable resource dilemma (both energy and mineral). This activity provides the basic tools for developing an understanding of resource depletion curves.

Objectives:

To model the depletion of a natural resource.

To plot graphs showing resource depletion.

To interpret the meaning of resource depletion graphs.

Grade Level: 9-12

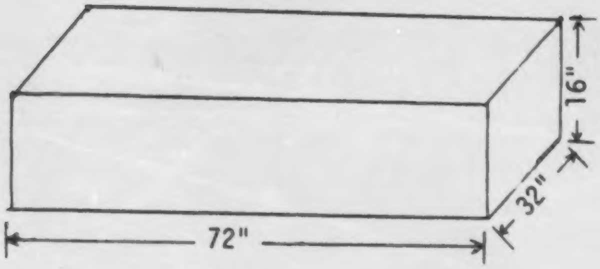
Time: Two or three class periods

Materials: Handout #25, "Resource Depletion"
Refrigerator box, cut down
Styrofoam chips
Black spray paint (a kind that will not dissolve styrofoam)
Copies (or transparencies) of the set of six resource depletion curves
Graph paper

Procedure:

Since a teacher must gather his/her own materials, only approximate directions can be given. The recomended box is a cut down refrigerator box (obtained free from a local appliance dealer). The strength of the box can be increased if the sides are folded over as the box is cut down. The box should be no higher than 12-18 inches. Otherwise, students will lean on the sides and break the box if they have to bend over to mine in it. The following are typical dimensions for such a box:

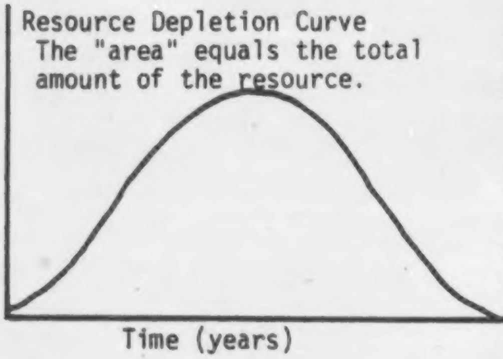
Activity by John W. Christensen

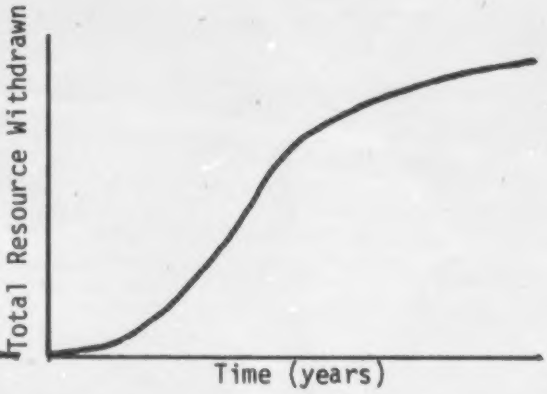


Fill the box to a depth of ten to twelve inches with styrofoam chips. Since styrofoam chips are expensive, have a local warehouse save them for you or have your students bring them in. With some ingenuity, you should be able to gather all you need at no expense to you or your school. The styrofoam can be of varying types because it represents earth material which varies a great deal. Withdraw about 1/20th of the total volume and place it in a large bag or cardboard box. Obtain a can of black spray paint (the kind that doesn't dissolve styrofoam). Spray the chips and shake the box until almost all the surface of all the chips is black. Let the paint dry for a day or two. Finally, add the painted chips (nuggets) to the box and mix in with the rest of the styrofoam. Place the box on a large desk or cafeteria-type table and you are ready.

Expected Results:

The results obtained should closely approximate the theoretical curves shown below:





Area = (barrels/year) x (years) = Barrels

Abnormalities in the curves obtained should not be ignored. Peaks can represent large new discoveries, dips can represent economic recessions, etc.

Sample Conclusions:

Rate of Withdrawal (Production) vs. Time

Resource production starts slowly, but as significant uses for that resource are discovered and profits are available, production grows exponentially. This continues until it begins to become difficult to locate and obtain that resource in abundance. As exploration costs rise and the grade of the resource (ore) drops, production declines exponentially. Companies drop out and the resource slowly approaches complete depletion.

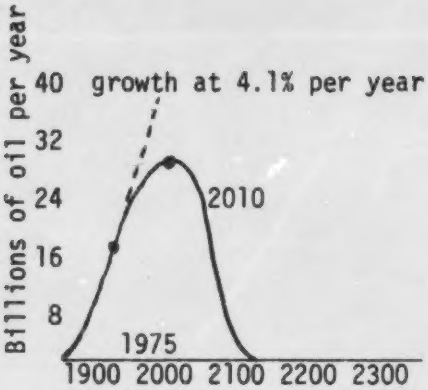
Total Amount Withdrawn vs. Time

When a resource is readily available, the total amount withdrawn increases rapidly because of great demand for it. However, after a significant portion of the total resource is withdrawn, the rate of withdrawal drops rapidly, even if the demand is there. Then as prices rise and profits dwindle, the demand drops off and production slowly drops to zero.

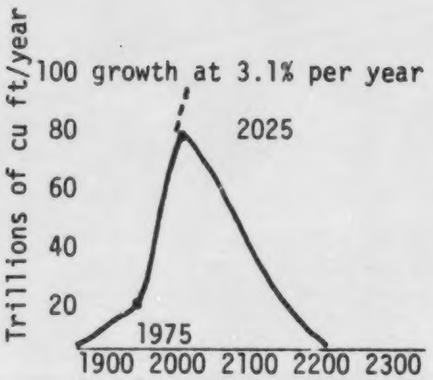
Post Activity Discussion:

Discuss the graphs and the conclusion for each one. What you do from there depends upon your class and your priorities. Suggested activities include:

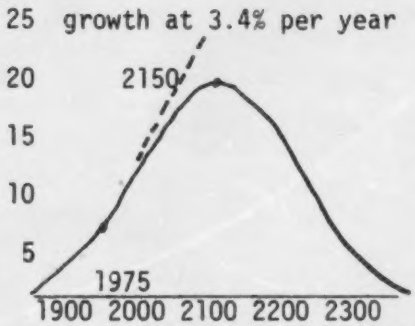
1. Discuss the Cycle of World Oil Production provided with the activity. Point out that the larger reserve estimate resulted in a greater demand and a steeper collapse so that 90 percent of the resource is gone at about the same time. What are the implications of the projection that 90 percent of the world's petroleum will be gone in about the year 2030? How should one plan for this?
2. Show the class the following set of resource depletion curves. What do they imply? Why do the reserves all run out at approximately the same time? How should we prepare for this? What role should individuals, schools, governments and industry play?



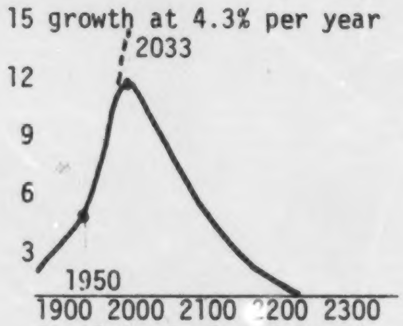
Complete Cycle of World Production of Petroleum Liquids



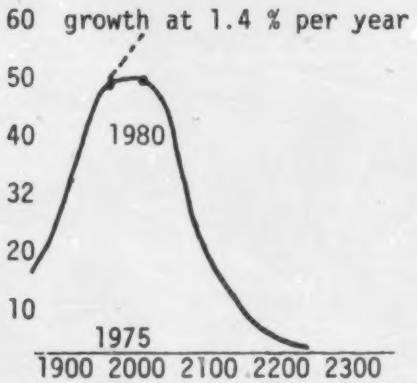
Complete Cycle of World Production of Natural Gas



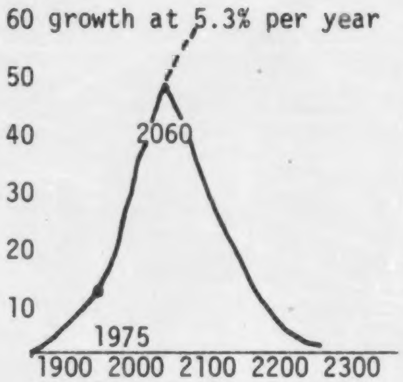
Extrapolation of World Coal Production, including Lignite



Complete Cycle of World Copper Production



Complete Cycle of World Gold Production



Complete Cycle of World Aluminum Production

(Resource depletion curves from Reed, C.B.: Fuels, Minerals and Human Survival, Ann Arbor Science Publishers, Inc., Box 1425, Ann Arbor, MI.)

3. The Way Things Really Are. Discuss the following statement:

Both the known reserves and the use rates change depending on weather conditions, economics, technology and world politics. In addition, lifespan estimates are made difficult by the problem--should we assume an increased or decreased preference for a resource with time? Also, should we include only reserves we can afford to extract now, should we include only those reserves we know exist, or should we try to guess at the extent of the undiscovered reserves and assume we will be able to afford to extract them? What recovery rates should we assume? One key point that must be understood is that the assumptions we start with greatly influence the lifespan we calculate.

Although no one knows for sure how much oil and gas lies under the ground, the degree of validity of any estimates of that quantity can best be verified against publically available information. This information is provided by the oil and gas industry, various private organizations, the U.S. government, and the United Nations. Analysis of this information leads to narrowly prescribed prediction of the approximate dates of critical events. These events include the approximate year when production will peak and the approximate year when 90 percent of a resource will be withdrawn. Although predictions will vary depending on the reliability of the data and assumptions used by the person making the projection, most predictions fall within a certain range of times. The best the lay person can do is examine the range of data and then draw his/her own conclusions.

4. Examine and discuss the following lifetime estimates:

RESOURCE LIFETIMES, U.S.
("Ultimately Recoverable Resources")

	Lifetime (In Years)		
Resource	Constant 1973 Consumption	With Increased Consumption	Doubling Time for Column 2
Oil	80	35	16
Natural Gas	112	30	8
Coal	693	70	15
Uranium*		27	3

*Based on 2,250,000 tons of U_3O_6 (Table 2-7) and 130 tons consumer per 6.6 billion kilowatt-hours.

RESOURCE LIFETIMES, WORLD

Resources	Lifetime (years)	Assumed Doubling Time (years)
Oil	35	9
Natural Gas	45	9

(from Fowler, John M.: Energy-Environment Source Book, National Science Teachers Association, 1742 Connecticut Avenue, NW, Washington, DC 20009)

5. Plot a graph of the U.S. Crude Oil Production vs. Time (1925-1975) and compare it to the projection provided. Consult a world almanac to update the data provided.

U. S. PETROLEUM PRODUCTION*
Source: Bureau of Mines; in thousands of 42-gallon barrels

1925	763,743
1930	888,011
1935	996,596
1940	1,353,214
1945	1,713,655
1950	1,973,474
1955	2,484,428
1960	2,574,833
1962	2,676,189
1965	2,848,514
1970	3,517,450
1971	3,453,914
1972	3,455,368
1973	3,360,903
1974	3,202,585
1975	3,056,779

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*Complete cycle of crude-oil production in the United States and adjacent continental shelves, exclusive of Alaska. From Hubbert M. King: "Energy Resources," Resources and Man, W.H. Freeman and Company, San Francisco.

6. Compare the Total Amount Withdrawn vs. Time graph you obtained in class with both the theoretical and actual set of graphs shown below:

KEY: $Q_{discovered} = Q_{produced} + Q_{in\ reserve}$ (Q=Quantity)

7. Determine the area under the Production vs. Time graph you obtained in class. Compare this answer to the total number of nuggets withdrawn.

Ideally: Area = Total Amount of Resource.

Possible Extensions:

1. You may wish to assess taxes on the companies. Example: Federal and State Tax = 3 nuggets/year (2 Federal, 1 State). Discuss severance taxes.
2. Discuss *The Limits to Growth* and other resource projections.
3. Discuss various pro- and anti-growth philosophies that are currently in the news.

References:

1. Hubbert, M. King, "Energy Resources," from *Resources and Man* (National Academy of Sciences), San Francisco, W.H. Freeman and Company, 1969, pp. 157-242.
2. Hubbert, M. King, "The Energy Resources of the Earth," *Scientific American*, Vol. 224, No. 3, September 1971, pp. 61-70.

3. Reed, Charles B., Fuels, Minerals and Human Survival, Ann Arbor, Michigan, Ann Arbor Science Publishers, Inc., 1975.

4. Meadows, Meadows, Randers, and Behrens, III, The Limits to Growth, New York, Universe Books, 1972.

5. World Energy Outlook (Exxon Background Series), Public Affairs Dept., Exxon Corporation, 1251 Avenue of the Americas, New York, NY 10020, 1977.

6. Current newspapers, journals and magazines.

A special thank you to Dr. Frank S. Mathews, physics professor at the Colorado School of Mines, for help in the design of this lab.

Title: EXPONENTIAL GROWTH CALCULATOR ACTIVITIES

Introduction: Population growth, growth in energy consumption, inflation of prices, and interest compounded in a bank account are examples of exponential growth. Exponents are used in mathematics as a shorthand to denote repeated multiplication. For example, in the number 10^7, 7 is an exponent. The 7 means you multiply 10 by itself 7 times: 10 x 10 x 10 x 10 x 10 x 10 x 10. Energy consumption grows exponentially because it is repeatedly multiplied by a number called the growth rate. Thus, if a certain town used 100,000 gallons of heating oil per year and has a consumption growth rate of 3.5 percent per year, next year the town will use 103,500 gallons of oil (100,000 x 1.035 = 103,500). If this growth rate continues, the town will use 200,000 gallons per year twenty years from now ($100,000 \times 1.035^{20}$).

The growth rate of energy consumption can be calculated by dividing this year's total consumption by last year's total consumption. By finding each year's growth rate for five years and taking an average, you can arrive at an average growth rate. Or you can use a low growth rate from a slow growth rate year to model slow growth and the growth rate from a fast growth year to model fast growth.

Population growth is related to growth in energy consumption because more people will consume more energy. This is especially important in the U.S. where each American uses forty to fifty times as much energy as a person in an underdeveloped country.

Population growth is exponential because each year the population is multiplied by the growth rate. Population growth rate represents the net gain of people per year. Roughly speaking the birth rate minus death rate equals the growth rate. (People moving in and out by migration also have to be added and subtracted.) When the birth rate equals the death rate, the population is stabilized at zero population growth.

The significant fact about exponential growth is that even small growth rates lead to a large overall growth in a relatively short period of time. Further, the growth is much faster than you might expect. For instance, it seems reasonable that with a growth rate of 2 percent the world population would double in fifty years to make a 100 percent increase. But in reality a growth rate of 2 percent causes a doubling in only thirty-five years. This is because exponential growth is compounded much like compounded interest in a bank account.

Objective:

Students will use calculators to calculate exponential growth in population and energy consumption.

Grade Level: 7-12

Time: Thirty to sixty minutes per worksheet

Materials: Handouts #26 - #30, "Exponential Growth Worksheets"
One calculator for every two students (any calculator that will multiply and divide with decimals can be used)

Procedure:

Step 1: Distribute calculators to the students. Have the students do some simple multiplying and dividing to familiarize them with the operation of the calculators. This will also help identify any calculators with dead batteries or mechanical malfunctions. For most students it is not recommended to use special exponent, log, memory, or % keys on the calculator. Exponential growth will be best illustrated by repeated multiplication.

Step 2: Distribute the Exponential Growth Worksheets. Demonstrate a few sample calculations from the worksheet and then let the students work in pairs to complete the worksheet.

Follow-Up Questions:

1. Are the population and energy consumption predictions you made in the worksheet accurate? Why or why not?
2. What are some other things besides population and energy consumption that grow exponentially?
3. What is the meaning of the term "doubling time?" Why are we concerned with doubling times?
4. What are some other countries in the world whose population has a higher growth rate than the U.S.?
5. What are some countries that have a higher energy consumption growth rate?
6. Should the U.S. try to attain zero population growth?
7. Should the U.S. try to reach a point of no growth in energy consumption?

8. What problem might arise from no growth policies in energy and population?

Pat Gore and John Masoncup

TEACHING ENERGY FACTS

Title: ENERGY QUICKIES

Introduction: This series of five starter activities is designed to stimulate interest in the field of energy.

Objective:

To spur interest in energy

Grade Level: 6-12

Time: Varies with activity

Materials: None

Procedure:

Write the following five activity suggestions on the chalkboard. Groups or individual students can choose one or more of the following activities to do and report their findings back to the class.

Suggestion 1: You will need a camera and film for this activity. Any camera will do, but a polaroid is preferable because of the fast development time. Take a series of pictures of energy. Any definition will do.

Suggestion 2: Count the number of electric lights in your house. Then count the number of houses on your block. Multiply the number of houses times the number of lights in your house. Using a city map, calculate the number of blocks in your city, then multiply that number times the number of lights on your block. How many lights do you find? Find out how much energy would be saved (in Kilowatt hours) if your city eliminated 50 percent of its electric lights.

Suggestion 3: Write a script for and act out a one-act play entitled "The Year the Lights Went Out."

Suggestion 4: You will need a portable cassette tape recorder for this one. Record as many different sounds as you can find that energy makes.

Suggestion 5: List at least one nonelectrical energy consuming alternative for each of the following items:

Television ____________________

Stereo ____________________

Dishwasher ____________________

Telephone ____________________

Clothes Dryer ____________________

Light Bulb ____________________

Gary R. Smith

Title: WHAT ARE THE POWER USERS?

Introduction: Modern American households are full of many items that use power of various forms. The purpose of this activity is to give the students an opportunity to list and examine what these power-users are. It is interesting to examine the various sources of power used in the home.

Objectives:

To list and examine things around the house that use power.

To classify the items according to kind of power used.

To determine what kinds of power are used most frequently at home.

Grade Level: 1-12

Time: Part of two class periods and time at home.

Materials: Pencils and paper

Procedure:

Step 1. Have a short class discussion about things which use power. Include the following kinds of power in the discussion: oil, battery, gasoline, electric, natural gas, hand power, air, and solar. Some examples are:

battery:	flashlight, toy robot
gasoline:	lawn mower, car
electric:	lights, refrigerator
natural gas:	furnace, water heater
hand power:	food grinder, can opener, broom, screw driver
oil:	oil lamp, some furnaces
air:	toy pinwheel, wind mill, clothes line
solar:	greenhouse

Step 2. Ask the students to make a list of as many things as possible in their homes which use power of any kind.

Step 3. The next day in class ask students to organize the items in their lists according to the kinds of power used (refer to the above examples).

Step 4. On large sheets of paper (or on the chalkboard) write the following headings:

A. battery
B. gasoline
C. electric
D. natural gas
E. hand power
F. oil
G. air
H. solar

Step 5. With the students referring to their own lists, compile a master list which will include everything on all the lists the students made at home.

Step 6. When the master list is complete, discuss it using the following questions:

A. What do you notice first about the lists?
B. Do some categories include more items than others? Why?
C. Can you see any items in the lists which could be powered differently? (Or do some items appear in more than one list? Example: can opener and electric can opener.)
D. What items in your home could be hand powered instead of being operated by batteries, electricity, or other power?

Step 7. Does this list give students any insights into the Energy Crisis? What are they?

Step 8. Have students list ways in which we consume energy wastefully. List ways in which we consume energy wisely. List changes they would like to make in the ways they and their families conserve energy.

Gary R. Smith

Title: ENERGY USING GADGETS

Introduction: The average household has about twenty-nine small electrical appliances that use almost 10 percent of the energy consumed in the home and cost us precious dollars to operate. Some of these gadgets are necessary and helpful in everyday living, but the majority are "convenience gimmicks" that are wasteful and inefficient. Simple tasks like carving meat, combing hair, brushing teeth, washing dishes, squeezing juice, and opening cans should be performed with human energy and not electrical energy.

Objectives:

To demonstrate an increased awareness of student energy consumption.

To collect and categorize data.

To identify alternatives for some energy consuming products.

To determine amounts of energy consumed by household appliances.

To demonstrate skills in data interpretation.

Grade Level: 5-12

Time: One to two class periods and time at home

Materials: Handout #31, "Energy Cartoon"
Handout #32, "Energy Using Gadgets"

Procedure:

Step 1. Distribute handout of cartoon to students. Probe them for their interpretations of the cartoon using the questions provided.

Step 2. Have students identify the appliances shown in the cartoon. How many of them are in their own homes?

Step 3. Distribute "Energy Using Gadgets" (three pages). Directions are provided. This activity requires some work at home. Students will list each energy producing gadget or appliance in their homes.

Step 4. After they have gathered their data, students then complete the chart, "Energy Using Gadgets." Encourage students to categorize their data.

Step 5. Have students determine actual energy consumption of each appliance. To calculate the number of kilowatt hours (kwh) used per month, multiply the wattage by the number of hours you expect the appliance to be used in one month. This will be the number of watt hours. Divide by 1000 to get kwh.

Example: Electric coffee pot used 1/2-hour per day:

$$\frac{15 \text{ hrs/month} \times 890 \text{ watts}}{1{,}000} = 13.4 \text{ kwh/month (multiply by 12 for kwh/year)}$$

Step 6. Encourage students to verbalize responses in the column labeled "substitute." Have they ever actually used or done the substitute activity?

Step 7. It is important to stress that although many of these small appliances consume little energy, it nevertheless takes a great deal of energy to produce them.

Step 8. Connect this data-gathering activity to the following discussion prompters:

A. People in the U.S. consume 100 times the amount of energy as the average person living in South America.

B. The U.S. is 6 percent of the world's population and consumes 40 percent of the world's resources.

Follow-Up:

Ask students to actually do several substitute activities for one week. Example: Towel dry hair instead of using a hair dryer.

Jacquelyn S. Johnson

Title: ENERGY ALTERNATIVES AND THE ENVIRONMENT

Introduction: In considering possible energy alternatives, it is necessary to assess the kinds and amounts of potential damage to the environment. Students are given a chart to fill in after they have researched each source.

Objective:

To research and record the impact of energy alternatives on air pollution, land use, water pollution, and possible large scale disasters.

Grade Level: 9-12

Time: Two to three hours

Materials: Handout #33, "Environmental Impact and Energy"
Progress Reports of the EPA from Environmental Protection Agency, Office of Research and Development, Washington, DC 20460.

Procedure:

Step 1. If possible, obtain copies of the various Progress Reports of the EPA. These materials can be used by students to research the handout.

Step 2. Distribute copies of the handout, "Environmental Impact and Energy." Ask students to fill out chart as instructed.

Step 3. Discuss their answers. Compare with the answer sheet.

Follow-Up:

1. Which energy sources would have the most devastating effect on the environment if used as major sources in the future?
2. Which sources would have the most benign effects?
3. How feasible and practical would conversion to solar power be? Wind power?

John W. Christensen

ENVIRONMENTAL IMPACT AND ENERGY

ANSWER SHEET

Rank the potential environmental hazard of the sixteen energy options listed as being low, medium, or high in the four categories listed. When you finish, turn your results in to your teacher. You will need this ranking later when you try to anticipate your energy future.

Energy Options	Air Pollution	Water Pollution	Land Use Impact	Possible Large Scale Disasters
conservation	less	less	less	none
coal	high sulfur particulate	high thermal	high	high-job hazard moderate-landslides
new fuels from coal	low	high	high	same as for coal
conventional reactors	low	low except for thermal	medium uranium is often mined open pit	meltdowns, sabotage, storage problems,
breeder reactors	low	low except for thermal	medium--same as above	Same as above except for weapon proliferation
solar heating and cooling	low	low	low	none
solar photovoltaic	low	low	low to medium	none unless large power plants are sabotaged
solar thermal energy conversion	low	low	medium--of mirrors	none unless large power plants are sabotaged
solar sea power	medium--increasing CO_2 level	medium to high--could change ecology	low	unknown--could be a disaster to the ocean's ecosystem

Energy Options	Air Pollution	Water Pollution	Land Use Impact	Possible Large Scale Disasters
controlled nuclear fusion	low	low?	low?	small possibility of explosion at the reactor
geothermal energy	medium	medium-high	low-medium	earthquakes
wind power	low	low	low-medium	low
fuels from plants	low	low	medium	none
fuels from water	low	less	less	none
oil shale	medium	high	high	large socio-economic impact on a remote area
tar sands	medium	medium-serious	moderate	the U.S. just does not have that much tar sands

Title: SOLAR AND OTHER KINDS OF POWER

Introduction: This is a set of short descriptive readings which can provide students with background information about sixteen alternatives to the burning of gas and oil.

Objective:

To provide students with information about sixteen alternatives to the burning of gas and oil.

Grade Level: 9-12

Time: One to two hours

Materials: Handout #34, "Power Sources Conservation"

Procedure:

Step 1. Give each student a copy of the handout. Explain that several sources of power are described. Allow time for them to read through the handout.

Step 2. Have students categorize the sources into "Renewable" and "Nonrenewable" energy sources.

Step 3. Tell students to imagine that they are given $1,000 to invest in the development of four sources of power. Which ones would they select and why?

Debriefing:

1. Which sources of power are used in your community?
2. Do students favor energy conservation using alternative power sources, or must there be a combination?
3. Which source or sources of power do students feel will provide the energy of the future?
4. Which power sources present the most obstacles as practical alternatives to burning of gas and oil?

John W. Christensen

ANTICIPATING THE FUTURE

Title: ENERGY USES OF THE FUTURE

Introduction: One of two possible worlds awaits us in the future fifty years hence: a world with abundant energy or one in which energy is scarce. This activity gives students a chance to imagine what the world will be like fifty years from now.

Objectives:

To imagine what the world will be like in terms of energy fifty years into the future.

To write a story of the future.

Grade Level: K-6

Time: One class period

Materials: Pencils and paper

Procedure:

Step 1. Discuss what the students have heard about energy shortages and the use of power and energy in our society.

Step 2. Ask them to think about what the world will be like in fifty years if the energy crisis continues and worsens. Then have them imagine what the world will be like if the energy problems are solved (say, by solar uses) and energy is abundant.

Step 3. Divide the class into two groups. Have one group write stories about the world in fifty years with abundant energy. Have the other group write about a world fifty years from now with a critical energy shortage. It might be best to have them write about one day in the life of a person of their present age, or a person of the age they will be in fifty years.

Step 4. Kindergarteners and first graders may draw pictures rather than write stories, or the stories could be dictated to be written by older children, the teacher, or aides. Or, one story contributed to by members of the group could be written on the chalkboard or a large piece of paper.

Step 5. Read the stories aloud and compare ideas from the two groups.

Step 6. Ask the students which world they think we will have. Why?

Step 7. Which world would they prefer? Why?

Step 8. What do students think would need to be done to have abundant energy fifty years from now?

Gary R. Smith

Title: LOOKING FORWARD: IT IS THE YEAR 2000*

Introduction: A major purpose of the following exercise is to demonstrate a technique designed to encourage an analytical study of specific environmental problems. Then, through the technique of brainstorming, action programs are recommended which address themselves to specific environmental concerns.

Objective:

To brainstorm the consequences of our current behavior in terms of determining future crises.

Grade Level: 7-12

Time: One hour

Materials: Handout #35, "It Is the Year 2000"

Procedure:

Step 1. Ask that students divide themselves into small groups of five to ten each. (5 min.)

Step 2. Have each group appoint a recorder.

Step 3. Give each group, on a separate slip of paper, one of the problems from the handout.

Step 4. Go over the following directions with the students:

Your group should imagine you are now living in the year 2000 and that you are experiencing the problem which appears on the slip of paper given to you. Your charge is to brainstorm the kinds of questions which should have been raised back in the early 1970s, 1980s, and 1990s to cope with the situation then prevalent before it became a momentous problem by the year 2000. ** Do not make statements or suggest solutions to your group's problem. Raise questions only! For example, if your problem deals with a serious air pollution crisis, one of your questions might be: "Why did the federal government continue to pour hundreds of millions of dollars into more highway development back in the 1970s and 1980s when it was so apparent that cars, trucks, and buses contributed so heavily to air pollution?"

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*It Is the Year 2000 was originally developed by Mr. Charles Holtzer of the Colorado State Department of Education. Only a portion of the exercise is included here. Write to them to obtain the entire exercise.

Rules for Brainstorming:

1. Generate as many creative ideas as possible.

2. Do not criticize, make a judgement, or evaluate initially anyone's ideas. Evaluating and judging each thought which is presented limits creativity. Encourage each individual to suggest ideas, no matter how impractical they may sound. Wild ideas can generate new, sound approaches. One individual's wild, impractical idea might spark a more practical thought by someone else. So, be wild and creative! Combining, improving, and hitchhiking on ideas generated by another person should be encouraged.

3. After brainstorming as many questions as possible, each group should then rank the five to ten most important questions brainstormed in order of their priority, and write these on an overhead transparency. (Black grease pencil shows up best.) This is the time to judge and evaluate all the questions brainstormed in order to pick out those which are most significant.

An Extension Activity:

After all groups have made their presentation on questions they brainstormed, and after they have jotted down any comments made by others during their group's presentation, request that the groups meet separately once again. This time, brainstorm action programs which could and should be taken now in the 1970s to cope with and prevent their specific problem from reaching monumental proportions by the year 2000. The action-oriented recommendations should be based upon the questions raised by each group in the previous activity. After the brainstorming session, each group should rank in order of importance five to ten recommendations for action which deal with their specific problems.

Bring all groups back together again and have each group present their recommendations on the overhead projector. Again, encourage reactions by everyone to each recommendation presented.

Gary R. Smith

Title: CHANGE YOUR LIFESTYLE

Introduction: Many times students are asked to learn about conservation or energy-related problems without applying the process to their own lives. This activity asks the students and the teacher to change some aspect of their lifestyles which would effect their energy consumption and to report back how they felt about the experience.

Objectives:

To change one of more aspects of one's life from an energy consuming mode to an energy conserving mode.

To share related experiences and problems of energy conservation.

Grade Level: K-12

Time: Two weeks

Materials: Chalkboard

Procedure:

Step 1. Have students brainstorm several ways in which they could conserve energy. List these ideas without evaluating them on the board.

Step 2. Select ten ways which the class thinks would make the most significant contribution to reducing energy consumption.

Step 3. Vote on which one single item the class and the teacher would commit themselves to do and for the next two weeks have everyone do it.

Step 4. Make up a check list with everyone's name on it for the two-week period. Keep a daily record of the successes of complying with the task. Use the honor system to monitor the honesty.

An example: Use of an alternative form of transportation to and from school.

CHECK LIST

Name	Type of Transport.	No. of Miles Round Trip	M	T	W	T	F	M	T	W	T	F

Step 5. Option. As a class, research the amount of energy saved above.

Questions:

1. What elements of society would support conservation?
2. What elements of society discourage one from conserving?
3. What was the most difficult aspect of your experience?
4. Was there any enjoyable aspect of the experience?
5. If legislating conservation is difficult, what are some ways to get people to conserve voluntarily?

Pat Gore and John Masoncup

Title: CREATING AN ENERGY PLATFORM

Introduction: When a candidate runs for a public office such as state governor, his or her party usually summarizes its positions on important issues in a statement called the party platform. The policy statements in the policy platform are usually the result of compromises between the different factions in the party. A candidate must address most major issues in his platform so the voters will know where he stands.

Energy issues affect many different groups of voters such as farmers, ranchers, businessmen, consumers, the elderly, the poor, trade unions, environmentalists, factory workers, oil well owners, miners, truck drivers, etc. The party platform must contain some concessions to as many of these groups as possible so as to form a coalition of voters to elect the candidate.

Objective:

The students will write a party platform for energy issues and increase their awareness of the different points of view on energy issues.

Grade Level: K-12

Time: One to two hours

Materials: Construction paper
Magic markers
Safety pins
Masking tape

Procedure: This activity is recommended as one of the final activities of a teaching unit on energy. The activity is most effective after the students have been studying energy issues in their state and alternative forms of energy.

Step 1. Organize students into groups of six to eight. Instruct each group to select a party name, party solagans, and a candidate for governor. The group should use the construction paper to make campaign posters and campaign badges to pin on their shirts.

Step 2. Each group will draft a party platform which should include statements of position on most of the major energy issues in the state. The platform should be designed to appeal to as many groups of voters as possible. Each group would strive to write a platform that would actually enable a candidate to win in their state rather than an ideal energy platform.

Step 3. Each group will be allowed five minutes for the candidate to give a speech and present the party platform. Campaign slogans and posters can be displayed at this time.

Step 4. The class will vote by secret ballot for the candidate of their choice.

Alternative Procedures: The focus of the activity can be changed by having each party write a national platform for a presidential election or a more local platform for a city mayor election.

Instead of having each party try to write a platform that could realistically be expected to work, students can be assigned to role play as members of a special interest party. Each student group would be assigned a party name such as Environmentalist Party, Oil Industry Party, Consumers Party, Agriculture Party, etc. The students would then try to write a platform consistent with the point of view of the group their party represents.

Questions for Class Discussion:

1. Which party or candidate would you vote for? Why?

2. What changes would other parties have to make in their platforms to get your vote?

3. Which candidate and party platform would have the best chance of winning in this state? Why?

4. Which platform would appeal most to businessmen? Farmers? Environmentalists? Mining and oil companies? Liberals? Consumers? Conservatives? Industry Leaders?

SPECIAL ACTIVITIES

Title: ENERGY T-SHIRT

Introduction: T-shirts are a very popular fashion attire. Students can create their own design and increase their level of awareness of energy issues.

Objectives:

To make a design on a T-shirt about energy.

To become more aware of energy issues.

Time: One class period.

Grade Level: 4-12

Materials: White T-shirt

Procedure:

Step 1. Have students bring from home one T-shirt, preferably white.

Step 2. Purchase several boxes of fabric crayons and have students draw a picture of energy on the T-shirt. Place a thin piece of paper over the picture and iron the paper. The picture is a permanent part of the T-shirt.

Questions:

1. After everyone has had a chance to see each other's T-shirts, ask what are the different forms of energy?
2. Have the students put the forms of energy into two categories--one Kinetic (energy in motion) and Potential (stored).
3. Why did the students choose their pictures to represent energy?

Pat Gore and John Masoncup

Title: SOLAR HOT DOGS

Introduction: Depending upon where you live, this gadget will cook a hot dog in a few minutes to half an hour. You merely point the reflector at the sun so its rays are focused upon the hot dog. You need not be a craftsman to build it. Take these plans to your local hardware store and ask a friendly clerk for help. Or maybe the school shop teacher would be willing to barter.

Objectives:

To articulate about alternative sources of energy.

To manipulate materials to create a "solar hot dog cooker."

To articulate about the building process.

To assess the importance of harnessing solar energy.

Grade Level: 7-12

Time: Variable
Eating time--five minutes

Materials:
Handout #36, "Solar Hot Dog Cooker"
Handout #37, "Sunshine on His Eggs"
Advertisement
Hot dogs, buns, and condiments

Procedure:

Step 1. Build the cookers according to instructions in Handout #36.

Step 2. Buy hot dogs, buns, mustard, catsup, pickles, onions, etc.

Step 3. Let the class cook and eat the hot dogs.

Step 4. Distribute an advertisement for solar energy. Have students create their own ads for their Hot Dog Cookers.

Step 5. Distribute reading, "Sunshine on His Eggs."

Jacquelyn S. Johnson. Ideas from Roberta Rosen and Barbara Dunn, Cherry Creek Public Schools; and Sunshine Company, University of Colorado at Denver.

Title: POSTER CONTEST

Introduction: After students have learned about energy and the need to conserve it, they may be eager to express their ideas to others. This activity will give students a chance to express the ideas they have formed about energy conservation. This could be carried out by an energy-conservation campaign in your school or in your community.

Objectives:

To express ideas about energy conservation.

To make posters showing ways in which energy can be conserved and used wisely.

Basic Skills: A. Data interpretation
B. Picturing and communicating ideas.

Grade Level: K-6

Time: Twenty minutes for directions plus time for making the posters either in or out of school.

Materials: Poster paper and art supplies
Handout #38, "Energy Saving Tips"

Procedure:

Step 1. Briefly discuss what the class has studied about energy conservation. You may also want to discuss some of the energy-saving tips on the handout.

Step 2. Ask the students if they would like to make some posters that advertise the need to conserve energy. (It might be possible to get some support for a contest from a community organization such as Kiwanis, Lions Club, or the school PTA or Student Council. Perhaps the organization could provide some prizes.)

Step 3. Set up rules for the posters:
A. Size (minimum and maximum)
B. Medium (paints, chalk, crayons, etc.)
C. Deadline for turning them in.
D Criteria to be used in judging (originality, neatness, quality of ideas advocated, etc.)

Title: INVENT A TOOL

Introduction: This activity requires students to manipulate. Using ordinary "classroom junk," students create their own tools--tools that use no (nonrenewable) energy. Students complete the activity by developing an advertisement for their "tool." Ads will comprise a class Tool Catalog.

Objectives:

To manipulate materials to create a tool.

To articulate about alternative sources of energy.

To compare and contrast their new tools with tools and inventions of the past.

To articulate about the absence of energy (nonrenewable forms).

To articulate about the tool-making process.

Grade Level: 5-12

Time: Two class periods

Materials: Handout #39, "Invent a Tool"

Procedure:

Step 1. The teams of tool makers may have to gather some special materials of their own, but for most purposes the following materials should be sufficient. Gather in advance:

- wire
- pulleys
- string
- straws
- glue
- magnets
- scissors
- tacks
- clothespins
- straight pins
- mirrors
- paper clips
- tin cans (#10)
- safety pins
- masking tape
- small mirrors
- flat sticks and dowels
- paper tubes (mailing tubes)
- roll of brown paper
- elastic bands
- tongue depressors or popsicle sticks
- sheets of cardboard

Students can be asked to bring in some of these things or other "junk" that might be useful. You may want to ditto and hand out the list titled "Invent a Tool."

You may want to take pictures of this activity showing different tools in the making and/or being demonstrated.

Step 2. Describe the task. Tell the students the following:

They are going to invent and make a tool that uses no non-renewable energy.
They may work individually or in teams.
The tools are to be simple but real--they should work.
The ideas for the tools can be their own or chosen from the list provided.
The completed tools are to be demonstrated to the class.
Tools have to made in one or, at the most, two periods.
(Decide how much time you want to spend.)

Mention that there are two basic approaches: start with an idea of something that needs to be done and design a tool to meet the need; or look at the materials at hand and ask yourself, "What useful tools could we make with these materials?" Ask students to note which approach they are using.

Step 3. Group students according to their own preferences into teams of two. While the tools are being made, circulate among the groups. Give assistance as needed. Take some pictures. Help the teams find materials.

Step 4. Tool demonstrations. These should be relatively short, a few minutes each. Arrange the rooms so that everyone can see what is going on. Some explanation will go along with each demonstration, but the emphasis should be on demonstrating the tool's uses.

Step 5. Tryouts. After the demonstrations, take a break to allow others to try out the tools.

Step 6. Discussion. What did students observe about:

The energy needed to operate their tools?
The new tools as a whole?
Any particular tool?
The usefulness of tools?
Things that happened to them while making their tools?

Follow-Up:

If there is substantial interest in this activity, individuals might put together a "catalog page" with pictures and descriptions of their tools (purpose, materials, energy needed to operate, cost, etc.) in the style of the Sears Catalog.

Also a fun follow-up: Find an old Sears Catalog. (Often among garage sale treasures, second-hand book stores and who knows where else?) Compare the "new" inventions with the old ones. Fun comparisons with energy use can be found.

Jacquelyn S. Johnson

Adapted from Education Development Center, Inc., "What is Energy?," People and Technology (1973).

Title: SURVEY OF COMMUNITY ATTITUDES

Introduction: This activity contains sight survey questions created by the Federal Energy Administration. The randomly sampled national findings can be used to compare community attitudes and behavior with attitudes and behavior.

Objectives:

To survey people in the community regarding their attitudes about key aspects of energy issues.

To compare the community's attitudes with those taken in the national survey.

Grade Level: 7-12

Time: Two to three class periods

Materials: Handout #40, "Questionnaire"
Handout #41, "National Survey Results"

Basic Skills Focus:
A. Data Collection
B. Data interpretation
C. Values clarification
D. Interviewing

Procedure:

Step 1. Divide class into pairs of students.

Step 2. Distribute a copy of handout, "Questionnaire," to each student.

Step 3. Using a city map, divide the community into sections. Ask students to survey a minimum of ten persons per pair.

Step 4. After students have collected data, appoint a committee to tabulate the results and put them on the chalkboard.

Debriefing:

1. What particular questions evoked the strongest response from interviewees?

2. How do your community's attitudes compare with those on the national survey? Distribute copies of handout, "National Survey Results."

Gary R. Smith

HANDOUTS

ENERGY AWARENESS QUIZ

Handout #1

1. How long would a 100 watt bulb burn on the energy needed to manufacture one aluminum soft-drink can?
   a. under 10 minutes
   b. 5 hours
   c. over 20 hours

2. How much energy stored in crude petroleum is lost in the series of processes between the oil well and a moving car?
   a. 20%
   b. 60%
   c. 90%

3. How much of the energy stored in coal which is burned in a power plant can be delivered to the customer's home as electricity?
   a. 1/3
   b. 2/3
   c. all of it

4. The total amount of electricity used by all small appliances, including radios, toasters, clocks, shavers, and so forth, is what percentage of the total amount of electricity used in our homes?
   a. 10%
   b. 30%
   c. 75%

5. The United States, with 6% of the world's population, consumes what percentage of the world's available energy each year?
   a. 10%
   b. 20%
   c. 30%

6. The average North American family uses how many times more energy than the average South American family?
   a. 5 times more
   b. about the same
   c. 100 times more

7. Which is a more energy efficient mode of transportation: walking or riding a bicycle?

8. How many years did it take nature to make a pound of coal?
   a. 100 years
   b. 1,000 years
   c. 1,000,000 years

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9. Of the solar energy coming to the earth, on the average, what percentage is used by plants to produce food energy for animals?
   a. 50%
   b. 20%
   c. 1 %

10. A returnable bottle is reused how many times?
   a. two times
   b. six times
   c. fifteen times

11. In the United States, what percentage of our energy comes from nonrenewable fossil fuel reserves?
   a. 50%
   b. 75%
   c. 98%

12. One ton of average municipal solid waste contains the energy content of:
   a. 1/3 ton of coal
   b. 1/2 ton of coal
   c. one ton of coal

13. True or false. The yields per acre of farms using heavy machinery are higher than those using labor intensive farming.

14. What percentage of the energy it takes to manufacture an aluminum can does it take to recycle it?
   a. 3%
   b. 15%
   c. 50%

15. To grow, process, and deliver food to the consumer takes how much energy compared to the food energy we get from eating the food?
   a. the same amount
   b. one-half the amount
   c. ten times the amount

16. In Japan, a rice farm takes about 90 horsepower hours per acre for cultivation and harvesting. In a comparable United States rice farm, how many horsepower hours are used?
   a. 45
   b. 200
   c. 1,500

17. Between 1946 and 1968, the population of the United States grew by about 40 percent. In that same period, how much did electric power comsumption increase?
   a. same as population growth
   b. twice as much as population growth
   c. over five times as much as population growth

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18. If in 1980 one-half of the cars on American roads were to have an average fuel economy of 22 miles per gallon (compared to today's average of 14 miles per gallon), the annual fuel savings would be which figure, assuming the same number of cars for both years?
    a. 17 thousand gallons
    b. 17 million gallons
    c. 17 billion gallons

19. Optimum insulation of your house can save what percentage of your heating bills?
    a. 5%
    b. 20%
    c. 40%

20. A three-degree reduction in your temperature setting for your home heating furnace saves how much fuel?
    a. 3%
    b. 10%
    c. 50%

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RIGHTS

Handout #2

Every American should have the right to:

1. Have a dishwasher, trash compactor, washer, dryer, freezer, and any other appliances he can afford and might want.
2. Have as many children as he wants and can afford to support.
3. Build a wind generator in the backyard even if the neighbors think it is ugly.
4. Commute to work on a bicycle in safe bicycle paths. (Reserved for bicycles.)
5. Own a car and drive it whenever and however much he wants.
6. Own and drive a Winnebago or large camping trailer on vacation (if that is what he wants and can afford).
7. Observe and enjoy wildlife in its natural state.
8. Own a large speedboat and dune buggy for recreation.
9. Be assured (guaranteed) that any new house purchased will have maximum insulation and energy-saving features.
10. Live in a community that has preserved much of the beauty of natural surroundings.
11. Be free from exposure to unsafe substances in food.
12. Camp and hike in unspoiled wilderness.
13. Ride down a wild river.
14. Have access to cheap, convenient, reliable, mass transit systems in cities.
15. Have unhampered access to use of the sun for home heating. (Sun shining on your house cannot be blocked by neighbors.)
16. Be safe from the possibility of misuse of nuclear materials by terrorists or from radioactive poisoning from nuclear accidents in power plants.
17. Have a fire in his own fireplace whenever he wants.

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18. Buy any kind of car he wants and can afford.

19. Breathe clean unpolluted air and drink clean water.

20. Travel a long distance on vacation every year.

21. Use as much gasoline, natural gas, and electricity every year as he can afford.

22. Enjoy the convenience of throw-away cans and bottles.

23. Eat as much meat in his diet as he likes.

24. Set the thermostat at whatever level he feels comfortable.

25. Choose the type of heating he will have in his home. (Gas, electric, wood, fuel oil, solar.)

26. Live in a single family dwelling; own his own home.

27. Be educated in a carpeted classroom.

28. Take as many baths or showers as they want.

29. An equal amount of energy to expend as they wish.

30. Always get a free drink of water.

31. Have a vegetable garden that puts a strain on existing water supplies.

32. Oppose construction of highways and bridges that would change rural areas to urban areas.

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QUALITY OF LIFE SURVEY

Handout #3

CATEGORY	Highly Dissatisfied									Highly Satisfied
Your Family Life	1	2	3	4	5	6	7	8	9	10
Your Present Health	1	2	3	4	5	6	7	8	9	10
Your Leisure Time	1	2	3	4	5	6	7	8	9	10
Your Housing	1	2	3	4	5	6	7	8	9	10
Your Work	1	2	3	4	5	6	7	8	9	10
Your Community	1	2	3	4	5	6	7	8	9	10
Your Standard of Living	1	2	3	4	5	6	7	8	9	10
Your Education for Work	1	2	3	4	5	6	7	8	9	10
Your Education for Life	1	2	3	4	5	6	7	8	9	10
Life in the Nation Today	1	2	3	4	5	6	7	8	9	10

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RESULTS OF QUALITY OF LIFE SURVEY   Handout #4

CONDUCTED BY GALLUP INTERNATIONAL RESEARCH INSTITUTES

To measure the level or degree of satisfaction or dissatisfaction with important aspects of one's life, a 10-point scale was used. Each respondent was asked to point to the step on the scale that best represented his feeling of satisfaction or dissatisfaction with a particular aspect of his life. The top step represented the highest level of satisfaction and the bottom step the lowest level of dissatisfaction.

In the results reported below, the percentage for a given satisfaction represents the total score for the top three steps of the scale, and describes the "highly satisfied."

	North America	Western Europe	Latin America	Africa	Far East
Your family life	73%	64%	60%	18%	18%
Your present health	63	51	48	33	18
Your leisure time	58	48	51	30	13
Your housing	55	49	37	14	14
Your work	49	40	22	7	7
Your community	47	42	38	17	13
Your standard of living	46	35	36	5	8
Your education for work	40	28	26	6	6
Your education for life	36	25	32	4	4
Life in nation today	36	29	38	18	12

UNITED STATES

	National	Upper Income	Middle Income	Lower Income
Your family life	73%	83%	77%	67%
Your present health	63	73	67	55
Your leisure time	59	58	61	58
Your housing	55	69	55	50
Your work	49	52	48	50
Your community	47	48	48	46
Your standard of living	46	64	45	39
Your education for work	40	47	42	37
Your education for life	36	43	38	32
Life in nation today	34	36	30	37

Taken from Denver Post, November 7, 1976

c`1978 CTIR

ENERGY ATTITUDE SURVEY

Handout #5

1. Do you believe there is an energy shortage? ___yes ___no ___don't know
2. Do you believe you have been given a realistic picture of the energy situation facing the United States? ___yes ___no ___don't know
3. Do you believe most Americans are energy "wasters?" ___yes ___no ___don't know
4. Do you believe most Americans are energy "conservers?" ___yes ___no ___don't know
5. Do you believe Americans are "spoiled," self-indulgent, and reluctant to take responsibility for the future? ___yes ___no ___don't know
6. Do you believe it is the responsibility of every U.S. citizen to conserve energy voluntarily? ___yes ___no ___don't know
7. Do you believe Americans will conserve energy only when government controls are imposed? ___yes ___no ___don't know
8. Would you be willing to reduce your standard of living to conserve energy? ___yes ___no ___don't know
9. Do you believe you as an individual can make an impact on energy consumption? ___yes ___no ___don't know
10. Would you conserve energy to save money? ___yes ___no ___don't know
11. Do you think the money saved is worth the inconvenience of conserving energy? ___yes ___no ___don't know
12. Do you think the energy saved is worth the inconvenience of conserving energy? ___yes ___no ___don't know
13. Do you feel technology will "bail us out" of the energy shortage? ___yes ___no ___don't know
14. Do you feel you have any input or participation in the energy usage decisions made by your family? ___yes ___no ___don't know
15. Are you going to do something to save energy? ___yes ___no ___don't know

Source: Energy Conservation In The House, DOE, Oct. 1977

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ENERGY ATTITUDE TALLY

Handout #5

Question	Yes %	No %	Don't Know %
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			
11			
12			
13			
14			
15			
Additional Questions			

Find the percentages for each response. For example: if on Question 1 200 students respond; 100 say yes, 60 no, and 40 don't know, then the percent saying yes is 100/200 or 50%; saying no is 60/200 or 30%; saying don't know is 40/200 or 20%. (You may choose to use a calculator, especially if large numbers of students respond.)

Suggestions:

1. Survey your class separately to see if the study of energy has an effect.
2. You might print your results in the school newspaper.
3. Survey the teachers and administrators. Do their opinions differ much from the students?

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ENERGY PASSWORD

Handout #6

SUGGESTED LIST OF WORDS FOR PLAYING ENERGY PASSWORD

Kilowatt
Gasoline
Waste
Conservation
Appliances
Oil
Coal
Solar
Thermal
Steam
Turbine
Battery
Energy
Kinetic
Potential
Generator
Generate
Electricity
Volt
Amperage
Conversion

Power
Source
Current
Static
Regulator
Thermostat
Furnace
Experiment
Magnet
Polar
Circuit
Resistance
Wind
Heat
Reactor
Nuclear
Friction
Tube
Motor
Engine
Combustion

Insulation
Exhaust
Consume
Electron
Proton
Neutron
Fuel
Positive
Negative
Reaction
Environment
Helium
Propellor
Resources
Shortage
Reserves
Shale
Fission
Fusion
Fossil
Liquified

See how many additional words you can add to the list to make up new cards!

c 1978 CTIR

LOOKING BACK

GROWTH OF A CATALOG, FROM HOOP SKIRTS TO MICROWAVE OVENS

> In writing your name and address, do not endeavor to show us a sample of spread-eagle, but rather affect the simple, plain and perfectly legible signature of John Hancock.

That dictum was part of the instruction carried in Catalog #13 issued by Montgomery Ward and Company for the spring and summer of 1875. The inside front cover of the catalog also carried one of the earliest and certainly the strongest, pledges of consumer protection of a company: "We guarantee all our goods. If any of them are not satisfactory after due inspection, we will take them back, pay all expenses, and refund the money paid for them."

Advertising itself as the "cheapest cash house in America," Montgomery Ward was a product of the times. Rural America featured the country store where the selection was small and price was either a case of "take it or leave it," or an exercise in haggling when the farmer had eggs, butter, or goosefeathers to barter.

A stint as salesman to country stores gave Aaron Montgomery Ward an idea: sell direct to country people with a mail order store.

Ward's first catalog, a single sheet, made its debut in 1872. Aimed at farmers and mechanics, it advised: "You can see at a glance the difference between our Prices and what you have to pay your Retailer for the same quality of goods."

Among the 163 items listed were #70--8 pairs Ladies' White Cotton Hose for $1.00; #87--5 Linen Shirt Fronts for $1.00; #102--2 pair Buck Gloves, again for $1.00. In fact, most of the items were priced at $1.00 with such exceptions as #48--2 pair Men's Cassimere Pants for $3.00 and #54--one Gent's Cassimere coat $3.50.

Prepayment of the purchase covered postage as well as the goods. Customers were urged to "Send enough money. We will return the change."

If a man wanted an overcoat, the cheapest way to send it was by mail. What to do if the coat exceeded the four-pound limit? The garment was shipped in halves, in separate parcels, with a needle and thread!

Aaron Montgomery Ward wrote all of the early catalog copy and carefully examined products before he made any promises to his customers. An ad for pots and pans carried his qualification: "Manufacturer's measure. Will not hold as much as represented."

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The growth of Ward's catalog paralleled the gradual advance of living and working standards in the Mid-west and on the Great Plains. Soon Ward sold a Royal Crown Steel Windmill for $23. The steel tower was extra at 60 cents a foot.

For the lady of the farm, the catalog offered New Home, a $26 sewing machine that retailed elsewhere for $50.

The catalog continued to grow thicker. There was even a special Men's Abridged Edition of 600 pages that spared bachelors the trouble of wading through corsets, dresses, and wraparounds to find watches, harness or saws. But not all bachelors ignored women's fashions. One lonely rancher spotted a drawing of a model wearing a fetching dress. He wrote that he wanted a wife and would Ward please send him #1242.

Excerpted from Mobil Overview, Winter 1977-78, Vol. 1, No. 3, Mobil Corporation, New York.

c 1978 CTIR

POT CLEANERS

Wire ring dish cloth--Each-5¢, Per doz-54¢. Handled dish cloth--Each-8¢, Per doz-85¢. The sensible Pot Chain and Scraper is a new useful article, each ring is double, which makes it very durable--Each-10¢. Wash your dishes without putting your hands in hot water. This dish mop is made of cotton and is securely fastened to handle. Length, 12 in; weight, 4 oz; price each-8¢.

ACME HARDWOOD ICE CHESTS

$2.93 to $8.00 The best-made ice chest on the market. Weigh from 65 to 180 lbs. Made of hard wood, has beautifully carved panels, is lined throughout with extra heavy metal, wooden slat rack on bottom for ice, heavy metal shelves. It is mounted on the very best antifriction casters.

LEMONADE SHAKERS

#16440. Price each-4¢. Liquor Mixers or Lemonade Shakers of tin. Size, 5-1/8x2-3/4; weight, 5 oz.

BROOMS

All our broom handles are thoroughly seasoned. The brooms are warranted not to come off the handles. Whisk Brooms, priced 8¢ to 20¢; House Brooms, priced 20¢ to 28¢; Stable Brooms, priced 28¢ to 50¢.

CLOTHES PINS

#16735. Hoyt's spring clothes pins. Price per doz-5¢, per gross-38¢.
#16737. Clothes pins, standard goods. Price per gross-15¢, per box containing 5 gross-50¢

EXTRA FINE NAIL BRUSHES

5 rows of imported bristles, white bone handles, a brush that druggists and retail dealers usually ask 15¢ for. Price each-8¢.

BROILERS

#16108. Has two sections--the cover, and the corrugated cross pieces into which the gravy drips during broiling. It is thus self-basting and instead of the gravy falling into the fire, creating a suffocating smoke and disagreeable odor, it runs into the corrugations, is broiled into the meat, making an otherwise dry, tough steak tender and juicy. Price each-40¢.

ICE TONGS

#15468. Price each-48¢. Opens 16 inches, steel point, family size.

EUREKA ADJUSTABLE CLOTHES BAR

Price each-39¢. Intended to fasten to the wall. When not in use takes the space of an ordinary broom. The bars are 3 feet in length with gilt tips; a very convenient household article.

c 1978 CTIR

DUST PANS

#16538. Whole sheet Dust Pan-7¢. #16540. Dust Pan, plain brown, covered-10¢. #16541. Fancy assorted colors, with brush-30¢

TUBULAR OR BARN LANTERN TO BURN KEROSENE

This is the most popular lantern on the market today. The crank at the side raises and lowers the globe and locks the burner in place when down. A late improvement on this lantern consists of a bend on the guard wire over which the crank moves, thus perfectly locking the globe frame and burner down. Price each-40¢

BISSELL

The best known and most widely sold carpet sweeper in the world. Price each-$2.30

THE WESTERN STAR WASHER

Price-$2.75. Capacity, 5 shirts or its equal in bulk. This machine is too well known all over the country to require any extended remarks. We wish to call attention to the fact that we do not use any nails in this washer below the waterline and that all iron parts that can come in contact with the clothing are heavily tinned, so that there is absolutely no danger of rust spots on the clothes. Weight, 61 lbs.

STROPPING MACHINE FOR SAFETY RAZOR

Price-$1.75

STERLING SUNSHINE STEEL PLATE RANGE

Price-$44.40. With high closet and reservoir for hard and soft coal or wood. It has no devices for mere show, it has every good feature that will promote utility, convenience and durability. The method of construction concentrates heat in the oven. The reservoir holds 15 gallons and the water is heated by a half-size water front by circulation, which does not interfere at any time with baking. Has six holes on top.

PURE ALUMINUM COFFEE POTS

Price-$1.50

ECLIPSE WASH BENCH

Price-98¢. High grade oak lumber with varnish finish. Folds up compactly and can be packed away when not in use. Something the neat housekeeper has been looking for.

RAZOR BLADE ACME LAWN MOWER

Price-$2.35. The mower has an improved cutter bar of solid tool steel, tempered and oiled. The knives have a positive shear cut and are regulated by the improved micrometer adjustment. All parts are interchangeable and can be replaced at once with little expense.

c 1978 CTIR

CHAMOIS NAIL POLISHER
Fancy Solid Sterling Silver mountings. Price-$1.90

COFFEE BOILERS
Flat bottom with bail. Price-27¢

ACME ROASTING PAN
Price-50¢. It is made of fine grade smooth steel.

COOK POT
Gray enameled, seamless, with heavy copper bottom. Price-44¢

VEGETABLE BOILERS
Copper bottom boilers. Price-25¢

LEMON SQUEEZERS
Bowls are made of malleable iron, nicely nickel plated; plunger from hard wood, and is detachable. The frame is of gray iron, japan finished; the handsomest and most complete lemon squeezer in the market.

GRAY ENAMELED STOVE POT
With bail and retinned cover. Pit and Flat bottom. Price-72¢

WAFFLE IRONS
Price-65¢

PANCAKE GRIDDLE
Made of wrought steel. Strong and durable, heats quickly.

SEWING MACHINE-MINNESOTA HEAD
High, strong and substantial with large space under the arm for sewing bulky goods such as cloaks, dresses, coats, etc.

BISCUIT AND CAKE CUTTERS
Price-3¢. Animals and birds, assorted styles. Price-4¢.

BEAUTY COMPLEXION MITTEN
Made of rubber will not irritate the skin, soft and flexible, this is really a toilet luxury once used always used. Price-48¢

SHAVING OR LATHER BRUSHES
Price-8¢, Black enameled handle Shaving Brush, medium size.

THE COLUMBIAN HAIR CLIPPER
Nickel plated, has detachable plates, all parts interchangeable. Price-$1.65

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FLOOR SCRAPERS
For cleaning and drying floors and windows, 12 inches wide. Price-30¢

CLOTHES SPRINKLER
With screw cover and handle. This is a new and very convenient article, used for sprinkling clothes before ironing. Price-12¢

MANGLES
Adapted for families, small hotels and laundries, restaurants, barber shops, etc. They do good work and endure a ton pressure. We can furnish these machines with tight and loose pulleys for power in place of hand wheel if desired, at $12.00 extra. Price-$28.12 each.

REVOLVING SLICER
For slicing apples, potatoes, pumpkins, cucumbers and other vegetables. Price-37¢

FRUIT PRESSES
Can be used for a variety of purposes; especially recommended for mashing potatoes. Potatoes after being forced through the strainer have a delicious creamy taste that no other method of mashing will impart. Price-30¢

A FINE PLATE MIRROR
Price 30¢ for 7x9 inches; 45¢ for 8x10 inches; $3.82 for 18x40 inches.

CURLING IRONS
It will pay you to include small ware in your order. Made of polished steel, polished wood handles, medium size, better than any other made. Price-4¢. Mustache curler, Price-5¢

RAZOR STROPS
Price-30¢

THE MERRY SUNSHINE HEATER
Revertible flue Parlor Stove. Stove has full nickel top, Ransom's improved duplex grate and shaking rings. Price $17.40

EGG POACHER
Designed to be placed within a spider or cooking vessel containing boiling water about one-half inch deep. Its merit is very evident, each egg is of uniform size, perfectly cooked. Price-25¢

FIRST PRIZE DOG POWER
This power can be operated by a dog, goat or sheep; yields 25% more power from a given weight of animal than any other, and with adjustable bridge to regulate the required power and motion, a 30-pound animal will do the churning; if you keep a dog, make him "work his passage." The power can be connected to any churn sold by us. Price-$15.00

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HAIR BRUSH
Price, 3 for 25¢

FANCY CLOCK
Finished in gilt or silver plate; height, 5-1/8 inches; dial, 2 inches, beveled glass, good lever movement made by the Waterbury Clock Company. Price $2.10. Same as above with alarm, price-$2.52

ICE CREAM FREEZERS
With lightning quadruple motion, automatic scraper, famous wheel dasher and combination hinge-top gearing. Tub is cedar with round electric welded wire hoop. Price-$1.43

WRINGER AND BENCH
With the ordinary tub wringer it is about as much work to hold the tub as to turn the wringer. The Bench Wringer does away with all this trouble. Price $3.00

CORN SHELLER
Price-95¢. This is the most simple and effective arrangement for corn shelling made. This sheller separates the corn from the cob, deposites the corn in the box on which it is mounted and the cob outside. It has a perfect tension that can be adjusted instantly and will shell all sized ears, popcorn to the largest southern dent. Price-95¢

CORN POPPER
Price-8¢

SUNK HOPPER
With hinged cover, iron finished with French gold bronze, white walnut box. Price-45¢

TOOTH BRUSHES
Price-3¢. Very fine and very soft for tender or sore gums. Price-17¢

FRY PANS
Stamped seamless lipped frying pans. Price-12¢

FOLDING IRONING BOARDS
Price-60¢

HAND MIRRORS
Price-19¢

WAVING IRONS
For waving the hair, made of good quality metal. Price-12¢

CAN OPENERS
Steel handle with brass ferrule. Price-10¢

LAUNDRY STOVES
With two 8-inch boiler holes and space on sides for nine irons. Price-$6

EGG BEATERS
Price-9¢

OUR EXTRA-HIGH UPRIGHT ACME REFRIGERATORS
Price-$10.40. It is manufactured of the very best kiln-dried ash lumber, beautifully finished antique, has solid brass locks, finest surface hinges, patent drip cup.

SAD IRON STANDS
Price-5¢

POLISHING IRONS
Price-30¢

BAKE OVEN
Price $1.15. Deep pattern with bails and covers. These ovens are designed for camp use and can be set in center of wood fire without injury to contents. Cover fits down snug so that nothing can get inside.

DASH CHURN
Common churns with long handle which goes through the cover at the top, with a dasher at the bottom which is worked up-and-down inside the churn. Price-56¢

CURLING IRON HEATERS
Can be used to heat a curling iron or heat a cup of water. Price-7¢

COMBINED ICE HATCHET, PICK and CHISEL
Price-50¢

GALVANIZED WASH TUBS
No leaking, no hoops to fall off, strong and durable. Price-60¢

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ELECTRIC BLANKET
Acrylic blanket with snap-on control and 5-year warranty. $36.00 twin, $59.00 queen. 180 watts

BLENDER
Hamilton Beach--$29.99. 14 speeds with high-low switch to double your choices, plus Insta-Blend for extra power. Includes 3 blend-store-serve containers. 33 watts

TABLETOP OVEN BROILER
$33.46. Cleans itself continuously while baking or roasting! Pushbutton controls for Baking/Roasting/Broiling. Door with full view glass window is removable for easy cleaning. 1,200 watts

BROILER/ROTISSERIE
Sale $46.99. G. Faberware "Open Hearth." Now you can enjoy outdoor cooking indoors. Air circulates freely, sealing in natural juices and allowing unwanted fat to drain off. Parts are immersible, heating element is self-cleaning, and it uses 30% less electricity than standard oven rotisseries.

ELECTRIC CAN OPENER
$6.96. Convenient, fully-automatic can opener stops when lid is open, has magnetic lid grabber, bottle opener. Save! 100 watts

CHICKEN BUCKET LOW PRESSURE FRYER
Wearever. Speed frying under low pressure makes chicken crisp but juicy in 13 to 18 minutes. Ideal for seafood and vegetables. Safe! Recipe book included. 4 qt. size, reg. $22.99, now $17.88; 6 qt size, reg. $26.99, now $21.88.

COFFEEMAKER
Anytime 5 to 9 cups, $8.88. Automatic temperature control brews 5 to 9 cups of coffee and keeps it serving hot. Lock-on cover--polished aluminum. 650 watts

COFFEE MAKER
Mr. Coffee. Sale $19.99. Brews perfectly in seconds, holds the heat hours. MCIA. 1,440 watts

ELECTRIC CLOCKS
Sale $15.20 Butcher block clock. 3 watts

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Handout #8

LARGE CAPACITY COFFEE PERCOLATOR
$14.99. 12 to 30 cup automatic perk, serves 4 guests or a dozen! Built-in temperature control keeps coffee serving hot, serve light, attractive colors or polished aluminum finish to enhance any decor. Avocado $15.99, Harvest $15.99. 1,500 watts

SLOW ELECTRIC STONEWARE COOKER
Rival Crock-Pot. Sale $24.99. Lift-out stoneware for carefree cleaning, cordfree serving and "fix ahead" dinners. The stoneware bowl is immersible and dishwasher safe. Recipe book included. 240 watts

CORN POPPER
$1 rebate offer. $3.99 sale priced. Your final cost $2.99. Available for use with Pan Handler, a big 3-qt corn popper attachment that automatically butters corn evenly. Rugged see-thru plastic. Mail rebate coupon available at all Skaggs Stores.

CROCKPLATE
Rival. $44.99. Does the work of ten appliances. It's a broiler, griddle, skillet, deep fryer, oven, wok, steamer, crepe maker, chafing dish and server. Stoneware lifts off for easy serving and cleaning.

CREPE MAKER
Contempra. $17.99, reg. $19.99. "Ready" light tells you when each crepe is done. DuPont Teflon II surface creates uniform thickness and easy removal. Just dip, flip and stack. Small Electrics: All May-D&F Stores.

CURLING IRON
Sale $9.99 Schick Quick Curl is ready to use in 60 seconds. New, fast, easy way to create curls that really last. Heat resistant safety tip. Convenient swivel cord. Non-stick coating. 15 watts.

ELECTRIC DEEP FRYER
Presto Frydaddy $28.90. Big enough to fry one-quarter of a chicken, fries four servings using only four cups of oil. Maintains frying temperature automatically. No controls to set. Presto hard surface non-stick coating inside and out. 1,000 watts

DISHWASHER
$469.95 6-cycle dishwasher with super scour cycle. Energy saving, 3-option heat selector. Exclusive in-the-door silverware and cutlery baskets. High-side racks, adjustable upper rack. 750 watts

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DAZEY DONUT FACTORY

$4 factory rebate. #DF-4. Makes four bakery-fresh donuts, quick and easy. Merit's low price $23.88 (Less factory rebate -$4.00) = Your cost $19.88 400 watts

HEAVY DUTY ELECTRIC DRYER

$169.00 4,860 watts

BLOW DRYER

Gillette $18.97 800 watts for fast, efficient drying. Two powerful settings. 3 great styling attachments for any length hair and style. Two combs and a styling brush, #9180. 800 Watts.

EGG COOK/POACHER

Oster $19.99 (reg. $23.99) Does as many as 8 hard or soft boiled eggs, and 3 perfectly poached. Cooker signals when eggs are ready for serving. Thermostatically controlled heat and non-stick surface make perfect eggs every time. Small Electrics: all May-D&F Stores.

ELECTRIC FAN

$17.00 Catalina 20" box fan. 2-speed motor and safety grills front and back. Sturdy handle for easy carrying. .85 watts

ELECTRIC EXERCISER

$199.99. Tripple-Action Electric Progress-A-Cyzer. Exercise action: seat and handlebar move in synchronized motion as you pedal to simulate riding, rowing, cycling. Electrically operated so you expend a minimum of effort. Construction: exclusive adjustment lets you vary the operating distance between seat and handlebar. Padded, vinyl-covered seat--height adjusts, stirruped vinyl pedals, plastic handlebar grips, leg tips. High-impact, gold color plastic cover encases mechanism. Electrical information: Safety reset button. 1 speed, ¼ HP motor. 700 watts. 6-foot cord. UL listed for 110-120 v, 60 c, AC.

FONDUE SET

Oster $26.99 (reg. $29.99) With thermostatically controlled heating element to cook fondues thoroughly without scorching. With separate temperatures for cheese, dessert and meat fondues. Includes six forks and holding ring. Non-stick surface for easy serving and cleaning.

FOOT FIXER

$29.97 #FF-1. Soothes tired, aching feet with thermostatically controlled heat and vibratory water massage.

GARBAGE DISPOSAL

$29.95 450 watts

c 1978 CTIR

Handout #8

FREEZER

Sale $209.95. Compact chest freezer 8.27 cu. ft. capacity. Wood grain vinyl clad exterior. Spring loaded hinges. Wall divider. 340 watts.

ELECTRIC FRY PAN

Sale $32.99 (orig. $36.90) D. Presto Submersible fry pan. Available in almond with earthtone brown accents. Presto hard surface coating inside and out for non-stick cooking and easy cleaning. Detachable Presto Control Master heating control maintains uniform heat from warm to 400 degrees. Model FP1fHD or FP15WD. 1,300 watts

MINI GRIDDLE

Toastmaster $17.88 #872. Versatile--can be used on counter or at table to prepare eggs, bacon, sandwiches and more. 1,500 watts

GAS GRILL

$199.99 ($224.70 value) Gas grill with big, 40,000 BTU twin burner and tank for LP gas. Twin, 13x15¼-inch bi-level cooking grates allow you to cook rare and well-done at the same time. Heavy-duty cast aluminum body and hood, 4-inch diameter post with dual burner controls. Housewares, downtown; all stores.

ELECTRIC KNIFE

Hamilton Beach $12.99 92 watts

BLOW HAIR DRYER Sale $16.99

Gillette Promax compact 1200 watts. Independent control of heat and air speed (4 settings). Concentrator attachment. Small and lightweight.

SINGLE HAMBURGER GRILL

$8.96 sale. Eliminate messy stove cooking with K-Mart Grill Chef. Quickly cooks square or round sandwich, hamburger. 400 watts

HOT DOGGER

$7.77. Van Wyck hot dogger makes hot dogs better. Try one and see! 1200 watts

HEATING PAD

King size moist or dry heating pad. Construction: 12x12 inches long. Gives warmth to large area of the body. Padded for softness; flexes to body contours. Lighted dial has graduated temperature settings. Waterproof vinyl liner allows moist heat applications. 2 snap-on cotton flannel covers. Machine wash, warm; tumble dry. Elec. info: UL listed for 110-120 v. 60 c AC. 72 watts, 6-foot cord.

IRON

General Electric Steam/dry iron $17.99 1200 watts

c 1978 CTIR

ICE CREAM MAKER
Proctor-Silex $24.99 Reg. $29.99. The 4-qt electric ice cream maker is fun for the whole family. With a sturdy plastic liner and charming simulated wood bucket. 156 watts

SUPER JUICER
$10.99 By Norelco. Compact, portable, battery operated citrus juicer. 1 pint capacity. No cords. 4 "D" alkaline batteries.

TABLE LAMP
$8.88 Choose from an assortment of stylish table lamps at this fantastic price!

BELT MASSAGER
$149.99. Deluxe ¼ HP Dual Post Belt Massager. Belts: 2 cotton bels with leather end strips massage 2 areas of body at same time. Speed and intensity: Multi-speed, 3-position stroke adjustment for gentle, moderate or vigorous massage. Construction: Dual posts for stability. Dark brown and beige enameled steel housing. Base has carpeted wood platform, steel frame. Measures approx. 36x17x40 inches high. Electrical Info: ¼ HP motor 500 watts, 7-foot cord. UL listed for 110-120 v, 60 c, AC.

DELUX MIXMASTER MIXER
Sunbeam $56.44 12-speed mix finder dial. 4-qt and 1½-qt mixing bowls, bowlfit beaters and dough hooks. Powerful 225 watt motor. Removes from stand for use as a portable. 225 watts.

HEAT MASSAGER
Orbital with a specially designed surface. $34.99 Massage action: "floating" head follows contours of your body. Unit transfers vibrations to 6 attachments for scalp, face, chin and general body massage. 2 heats, 2 speeds--choose gentle or vigorous massage, low or high heat or any massage/heat combination. Construction: Ivory-color Lexan plastic housing. Attachments won't chip or break. 6x3x10 inches long. Elec. Info: UL listed for 110-120 v, 60c, AC 45 watts. 7-foot cord.

ROLLER MASSAGER
$169.99 Multi-speed adjustment. Construction: 16 free-turning hardwood rollers. Brown wood frame, grained vinyl finish. Measures approx. 25½x 5¼x4 inches high. Elec Info ¼ HP motor. 500 watts, 6½-foot cord. UL listed for 110-120 v, 60c AC. Ordering info: Assembled, Warranted.

MICROWAVE OVEN
$389.95 Whether you are looking for a microwave with the automatic temperature control or the slow cooking goodness of cookmatic cooking or a microwave with slow-cook and defrost, Amana has the model for you. 1,500 watts

c 1978 CTIR

Handout #8

LIGHTED MIRROR
$26.99 Sale True-to-Light III by Clairol. Lets you make up in the light you will be seen in. 4-way light selection: day, home, evening, office. Adjustable mirrors permit panoramic view of your face. Center mirror swivels from regular to magnifying. 40 watts

RIDER MOWER
Sale $799.88 J.C. Penney rider mower with 11 HP electric start Briggs and Stratton engine. Features 5-speed transmission, headlight, 42" steel deck, full electrical system and two hitch.

HAND MIXER
3-speed $7.99 So lightweight and easy to use with fingertip controls. 130 watts

THE NAIL WORKS CLAIROL KIT
$11.99 Sale NM1 inc. attachments for manicure and pedicure.

ELECTRIC PEELER
G.E. $15.99 Takes the drudgery out of peeling. Lightweight and compact. Can be used under running water.

PIZZARIA PIZZA MAKER
$19.99 #M0368 Mirro's Pizzaria. Holds 12" pizza. Easy cleaning aluminum. 500 watts

CLOCK RADIO
Digital-Sale $34.95. Wake or sleep to FM-AM radio, or merely listen and enjoy. She will appreciate our Chronomatic 116 digital. 10 watts.

TOASTER
$9.99 Chrome with black. Toast the way you like. 2-slice. 800 watts

FOOD PROCESSOR
La Machine $54.77 Now you can be the proud owner of this most exciting appliance that chops, grates, slices, grinds and shreds in just seconds. It's like having a professional chef right at your side. La Machine takes the drudgery out of time-consuming food preparation chores and makes it a breeze to prepare everything from ordinary hamburgers to elegant gourmet meals.

FOOD PROCESSOR
Mighty Chef $59.97 It's the revolutionary new process. Super fast work saver. Cuts, chops, shreds, mixes, blends and kneads. Dual safety switches. Shatter resistant bowl. Now you will wonder how you lived and cooked without it. Power direct drive motor #1010. 150 watts

c 1978 CTIR

REFRIGERATOR/FREEZER
Sale $199.95 8-foot compact refrigerator, features 3 sliding shelves, crisper, dairy storage, interior light. 620 watts.

ELECTRIC ROLLERS
Sale $19.99 Lady Schick's Lasting Curls Mist Hairsetter is perfect for today's curlier hairstyles. Includes 20 rollers: 4 small, 10 large, 6 jumbo. It moisturizes while it sets. Red dot indicates when ready to use. 400 watts.

FOOD SLICER
Rival Protect-O-Matic $34.99 Slices: roasts, hams, breads, bacon, cheeses, fruits, cold cuts, vegetables. 100 watts.

RUG SHAMPOOER
$39.78 Hoover shampooer. Versatile, eliminates rental charges. Complete with shampoo brushes. 300 watts

SEAL-A-MEAL II
$11.57 Heat seals food into boilable bags. 8-, 24-, or 32-oz bags are $1.43/pkg. 58 watts

SEWING MACHINE
$70.88 Charge It! Complete with attachments, push-button reverse, blind stitch, drop feed, sews on buttons and lots more. The portabout sewing machine case $13.00 120 watts

LADIES ELECTRIC SHAVER
$15.99 Sale Remington ladies electric shaver. "Smooth & Silky"---this revolutionary shaving system is designed exclusively for a woman. Gently removes unwanted hair and leaves your skin smooth and silky to the touch.

CLAIROL SKIN MACHINE
Battery operated cleansing brush, comes with two soft nylon complexion brushes. Can be used with soap or skin cleanser. Fun to use!

VACUUM CLEANER
$29.99 Hoover Canister. It rides on a cushion of air! 675 watts

ELECTRIC SHAVER
$29.99 Head: adjust blade to low, medium or high level to suit your beard. Contoured design gives you a close, comfortable shave. Pops up to clean. Trimmer: built-in--trims sideburns and moustache. Construction: charcoal gray plastic housing and travel case. On-off switch. Elec. Info: UL listed for 110-120 v, 60c AC. 3-foot cord. 10 watts

c 1978 CTIR

STEAM CHEF
Waring Now $34.99 The first stackable whole meal cooker. Convenient. Not an all-day cooker. A pressureless steam cooker that prepares most meals in less than 30 minutes. Versatile. Simply pour water, beer or wine into bottom section; put meat, fish or poultry in the four-quart cooking bowl and your choice of side dishes in the divided upper two-quart bowl; stack and steam. Nutritious. Unlike boiling and baking, steam cooking retains essential vitamins and other nutrients.

SUN LAMP
$26.95 400 watts of tanning power, an automatic shutoff time, chrome reflector and plastic housing. A great Mother's Day gift at your favorite Woolco store.

SUPER SHOOTER
Wearever Sale $17.99 Fast, easy way to make cookies. Stuffs tomatoes, deviled eggs and pastries, too. With 9 shapes, one filler barrel loader. 17 watts

STEREO SYSTEM
$399.00 "The Complete Stereo System" Features both 8-track and cassette built-in tape decks. Built-in cassette and 8-track record/playback tape decks, VU tuning meters, AM/FM stereo tuner, Automatic changer with magnetic cartridge. 2-way speakers with 8" woofer, 8" passive bass radiator and 2" tweeter. 85 watts

TOASTER OVEN
$33.88 Toast-R-Oven Toaster. Bakes, top browns and toasts 4 slices. Removable racks. 1,500 watts

ELECTRIC TOOTHBRUSH
$16.88 6 brushes with medium nylon bristles clean and polish teeth, massage gums. Operating Info. 4-way action: up, down, side-to-side. Handle recharges in base. On-off switch. Construction: yellow and white plastic housing. Wall bracket. Elec. Info: UL listed for 110-120 v, 60 Hz, AC, 2-w, 4½ foot cord. 2 watts.

TRASH COMPACTOR
Trash Masher $219.95 Full-width, touch-toe drawer opener. Automatic deodorizing spray system. Bag storage compartment. Key-knob operation. 4-color panel pack. 460 watts/cycle

UPRIGHT VACUUM CLEANER
Save $20 $59.95, reg. $79.95 2-speed upright vacuum 460 watts

BLACK AND WHITE TV
Sale $84.99 Black and white TV at its best. 100% solid state--fewer repairs. In a lightweight, durable plastic case. Model 3K84 27 watts

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COLOR PORTABLE TV

Now $344.00 19 inch diagonal, modular solid state TV. Chroma-Brite black matrix picture tube. Automatic fine tuning (AFT) 100 watts

ELECTRIC TYPEWRITER

Brother typewriters $119.99 All are fully guaranteed. All have carrying case. Some are demonstator models, many in original cartons. 40 watts

AUTOMATIC WASHER

Whirlpool Sale $269 2-speed, 3-cycle. Great for permanent press. Water-saving water level control and temperature selector. White. Major appliances: all May-D&F stores except FC. 840 watts

ROUND WAFFLE BAKER

Sale price $16.74 (ends Sat.) New enjoy plate-size waffles! Round baker has non-stick grids, automatic thermostat to maintain selected temperature. 1,000 watts

SALTON YOGURT MAKER

GM-5 $8.99 Make natural yogurt at home. Makes 1 quart. Spoon and five jars. Thermostatically controlled.

WATER SOFTENER

$299.99 The convenience of soft water without high rental cost. This model features guest cycle for an extra regeneration. Softens enough water for five people with up to 40 grains hardness per gallon.

DENTAL AQUA JET WATER PIK

Sale $21.99 The oral hygiene appliance. One out of every ten Americans lose their teeth to gum disease. But you can help make sure it doesn't happen to you. Just stop in and purchase a Water Pik. 35 watts.

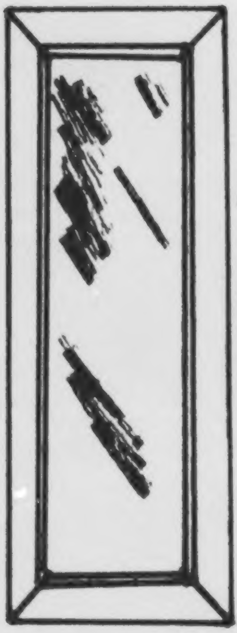
WHIRLPOOL BATH

$159.99 43-gallon Whirlpool Bath. Pump delivers approximately 43 gal. of water per minute at high setting. Aerator tube injects air bubbles into water. Advanced design has double barrel nozzle--use whirlpool and attachments at same time. Jet spray rotates 180 degrees. Construction: Heavy-duty white plastic. 23x8½x15" Elec Info: electrical parts are fully insulated, outside tub rim for safety. 1/3 HP motor. UL listed 110-120v, 60c, AC 360 watts. 8-foot cord.

ELECTRIC WOK

G. Faberware Special $49.99 Lets you enjoy Oriental cooking with ease. Exclusive Perfect Heat control keeps proper temperature automatically. Aluminum-clad bottom keeps sizzle in the center--prevents hot spots and scorching. And --- the contemporary styling makes it a beautiful at-the-table server, too. With recipe book and chopsticks. Model 303.

c 1978 CTIR



A Fine Plate Mirror for 30 cents

Name of item ______________________

Price ______________________

What does this item do? ______________________

Type of energy needed to operate ______________________

____

What has replaced this item today? ______________________

____

How does this item differ from the new one?

____

How are they alike? ______________________

____

- -

Waving Irons

Name of item ______________________

Price ______________________

What does this item do? ______________________

Type of energy needed to operate ______________________

____

What has replaced this item today? ______________________

____

How does this item differ from the new one?

____

How are they alike? ______________________

____

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Kerosene

Lantern

Name of item ____________________________

Price ____________________________________

What does this item do? __________________

Type of energy needed to operate _________

____

What has replaced this item today? _______

____

How does this item differ from the new one?

____

How are they alike? ______________________

____

- -

Wash Boards

Name of item ____________________________

Price ____________________________________

What does this item do? __________________

Type of energy needed to operate _________

____

What has replaced this item today? _______

____

How does this item differ from the new one?

____

How are they alike? ______________________

____

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Name of item ______________________

Price ___________________________

What does this item do? _____________

Type of energy needed to operate ________

____

What has replaced this item today? ______

____

How does this item differ from the new one?

____

How are they alike? ________________

____

Name of item ______________________

Price ___________________________

What does this item do? _____________

Type of energy needed to operate ________

____

What has replaced this item today? ______

____

How does this item differ from the new one?

____

How are they alike? ________________

____

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Corn

Popper

Name of item ____________________

Price ____________________

What does this item do? ____________________

Type of energy needed to operate ____________________

____

What has replaced this item today? ____________________

____

How does this item differ from the new one?

____

How are they alike? ____________________

____

- -

"Grand Rapids"

Carpet Sweeper

Name of item ____________________

Price ____________________

What does this item do? ____________________

Type of energy needed to operate ____________________

____

What has replaced this item today? ____________________

____

How does this item differ from the new one?

____

How are they alike? ____________________

____

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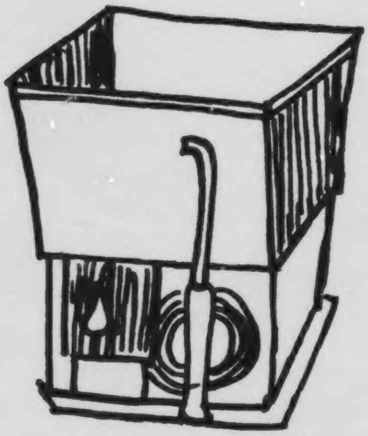


Name of Appliance ____________________

Price ____________________

What does this appliance do? ____________________

____

What type of energy is needed to operate this appliance? ____________________

How much energy does this appliance use? ____________________

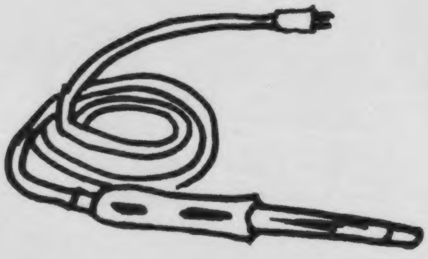
____

Is this appliance in your home? __________

List an item from the 1897 Sears Catalog that was used before this appliance was invented:

____________________ P# __________

- -



Name of Appliance ____________________

Price ____________________

What does this appliance do? ____________________

____

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How much energy does this appliance use? ____________________

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____________________ P# __________

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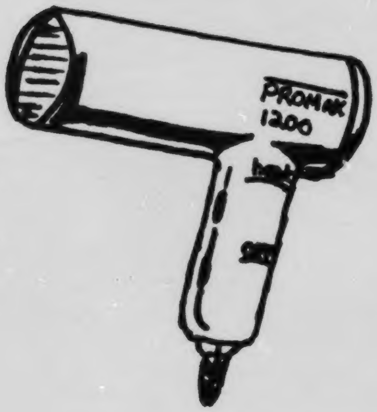
Name of Appliance ____________________

Price ____________________

What does this appliance do? ____________

____



What type of energy is needed to operate

this appliance? ____________________

How much energy does this appliance use? ___

____

Is this appliance in your home? __________

List an item from the 1897 Sears Catalog
that was used before this appliance was
invented:

________________________ P# ________

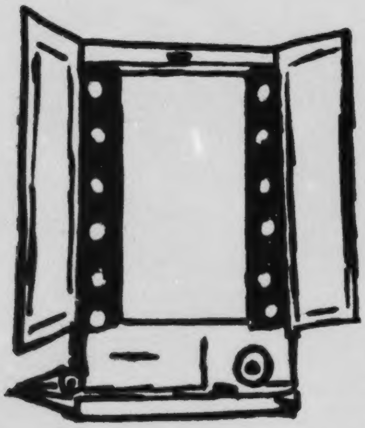
- -

Name of Appliance ____________________

Price ____________________

What does this appliance do? ____________

____



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this appliance? ____________________

How much energy does this appliance use? __

____

Is this appliance in your home? __________

List an item from the 1897 Sears Catalog
that was used before this appliance was
invented:

________________________ P# ________

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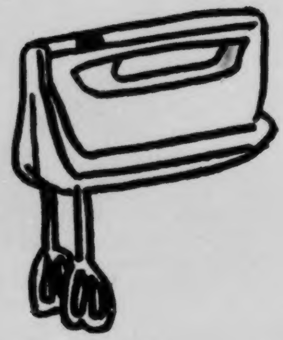


Name of Appliance ____________________

Price ____________________

What does this appliance do? ____________________

____

What type of energy is needed to operate this appliance? ____________________

How much energy does this appliance use? ____________________

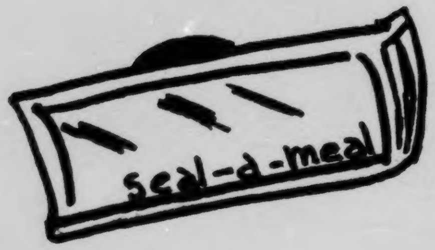
____

Is this appliance in your home? __________

List an item from the 1897 Sears Catalog that was used before this appliance was invented:

____________________ P# __________

- -



Name of Appliance ____________________

Price ____________________

What does this appliance do? ____________________

____

What type of energy is needed to operate this appliance? ____________________

How much energy does this appliance use? ____________________

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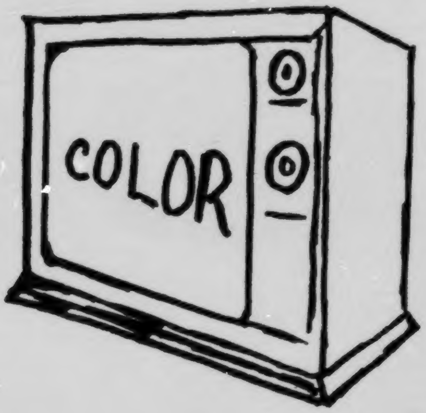

Name of Appliance ____________________

Price ____________________

What does this appliance do? ____________

____

What type of energy is needed to operate this appliance? ____________________

How much energy does this appliance use? ___

____

Is this appliance in your home? __________

List an item from the 1897 Sears Catalog that was used before this appliance was invented:

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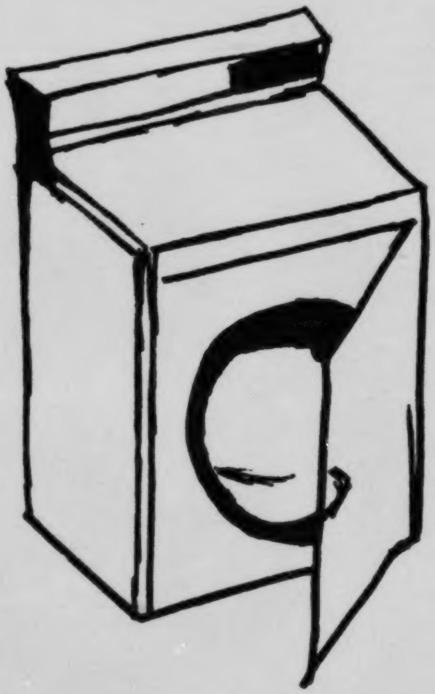
- -



Name of Appliance ____________________

Price ____________________

What does this appliance do? ____________

____

What type of energy is needed to operate this appliance? ____________________

How much energy does this appliance use? __

____

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____________________________ P# ________

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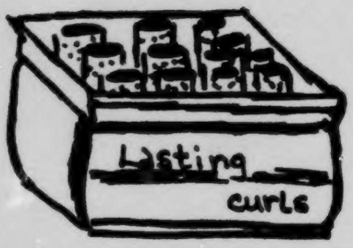
Name of Appliance ____________________

Price ____________________

What does this appliance do? ____________

____



What type of energy is needed to operate this appliance? ____________________

How much energy does this appliance use? ___

____

Is this appliance in your home? __________

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______________________________ P# __________

- -

Name of Appliance ____________________

Price ____________________

What does this appliance do? ____________

____

What type of energy is needed to operate this appliance? ____________________

How much energy does this appliance use? __

____

Is this appliance in your home? __________

List an item from the 1897 Sears Catalog that was used before this appliance was invented:

______________________________ P# __________

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OBSERVATION SHEET

Handout #9

Product Advertised	Does Product Represent Improvement to Conserve Energy?	Is This a New Product?	Source of Energy

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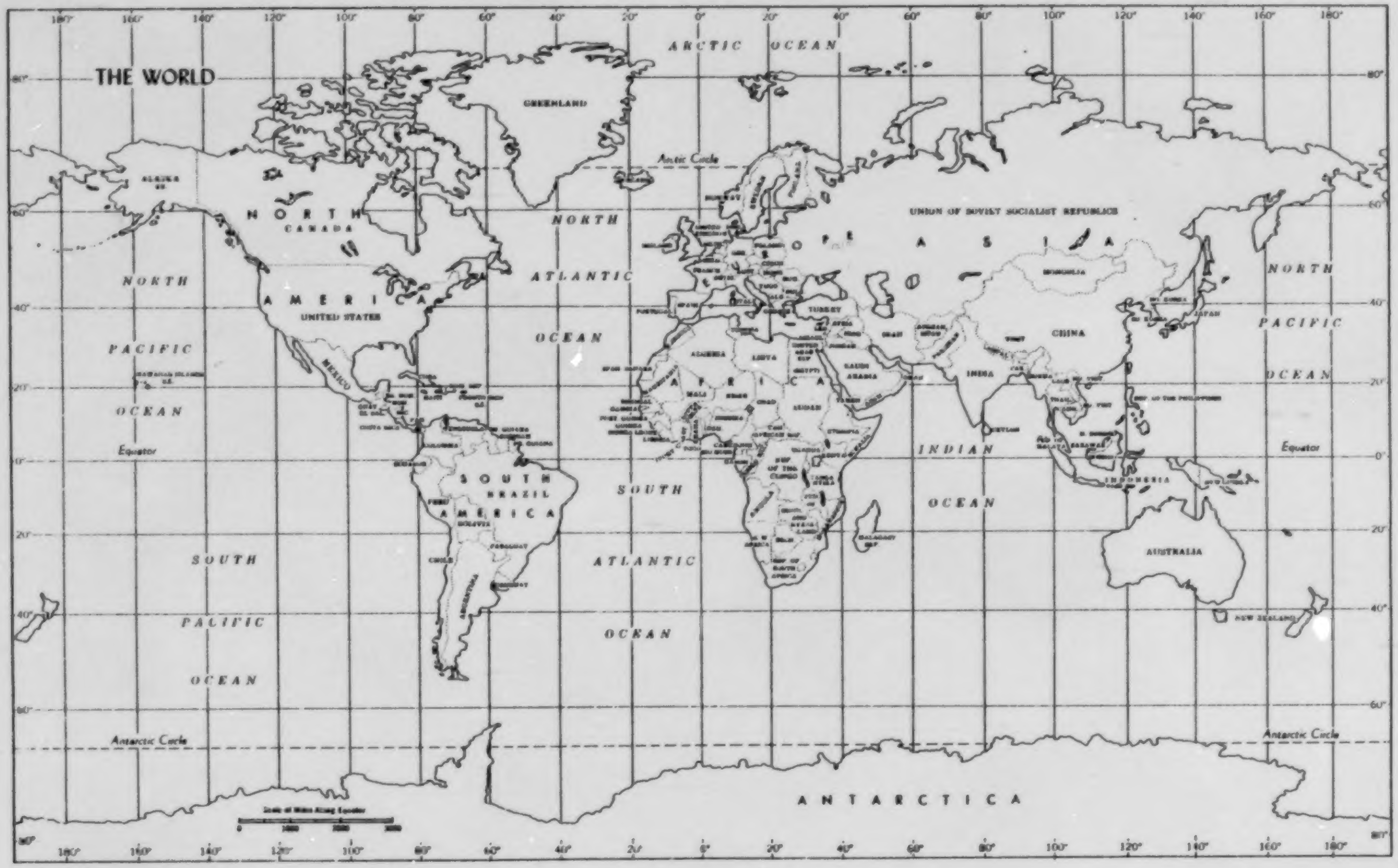

WORLD MAP

Handout #10

BEST COPY AVAILABLE

MAP SUGGESTIONS

Handout #11

1. Using various colored pencils, make a map indicating where most of the world's oil reserves are located. (You will need to create a legend.)
2. Using colored pencils, map the location of the world's coal reserves.
3. Make a population distribution map and compare the concentration of population with the concentration of energy reserves--especially coal and oil.
4. Using colored pencils, map the location of the world's lumber reserves.
5. Map either the world's aluminum reserves, copper reserves, gold reserves, or bauxite reserves.
6. Make a map (using colored pencils) of the richest nations in the world, per capita. How many are classified as rich nations because of their energy reserves?
7. Locate three countries in the world that have the most "balance" of energy reserves.
8. Make up two ways to use the maps to indicate energy problems.
9. Make a map showing countries which consume the most energy per capita, using colored pencils.
10. Locate and mark the "poorest" country in terms of energy. That is, the most energy-poor country.
11. Make two maps. The first map should divide the world into "have" and "have not" nations, according to per capita income. The second map should divide the world into "haves" and "have nots" according to per capita energy resources.

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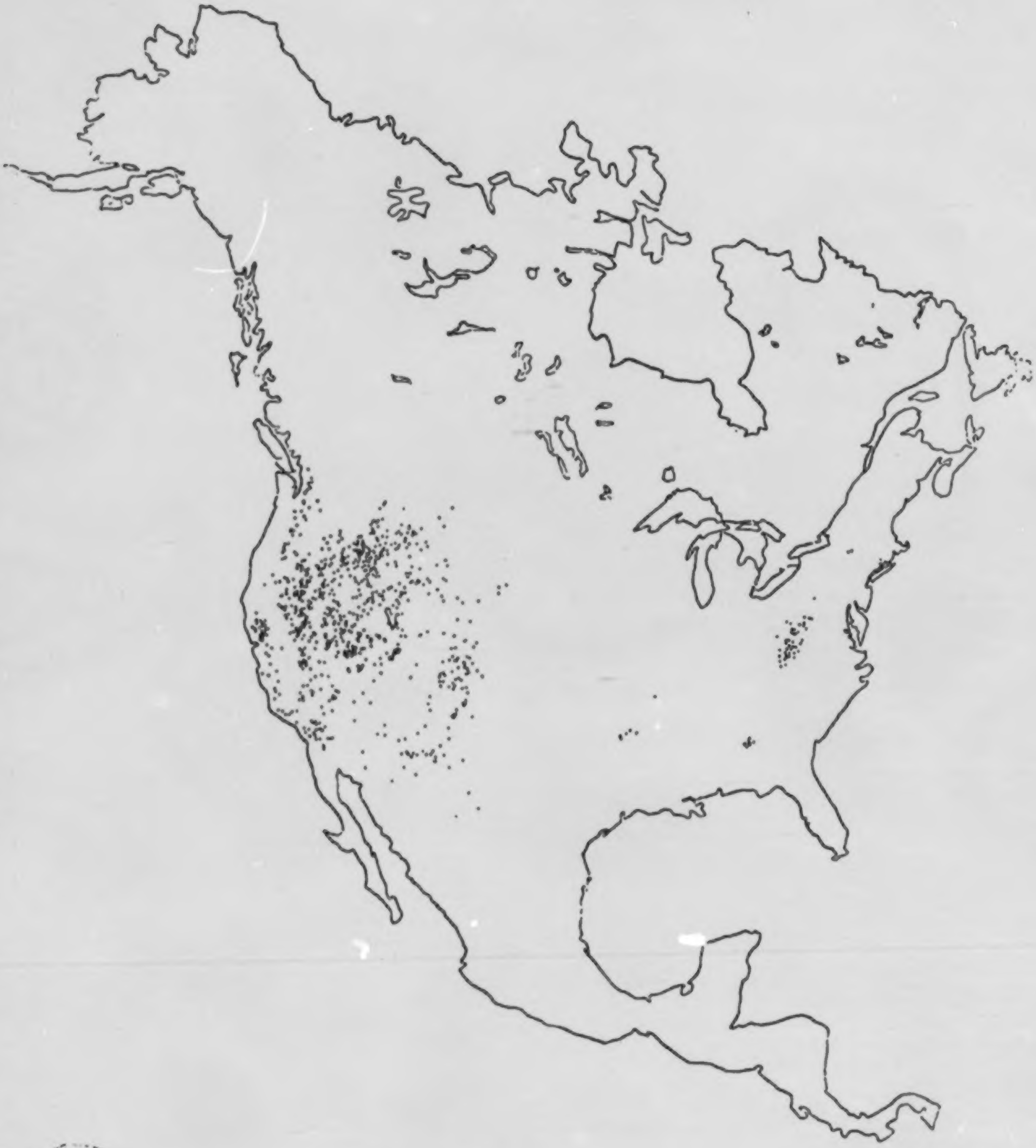
HOT SPRINGS

Handout #12

USA Only



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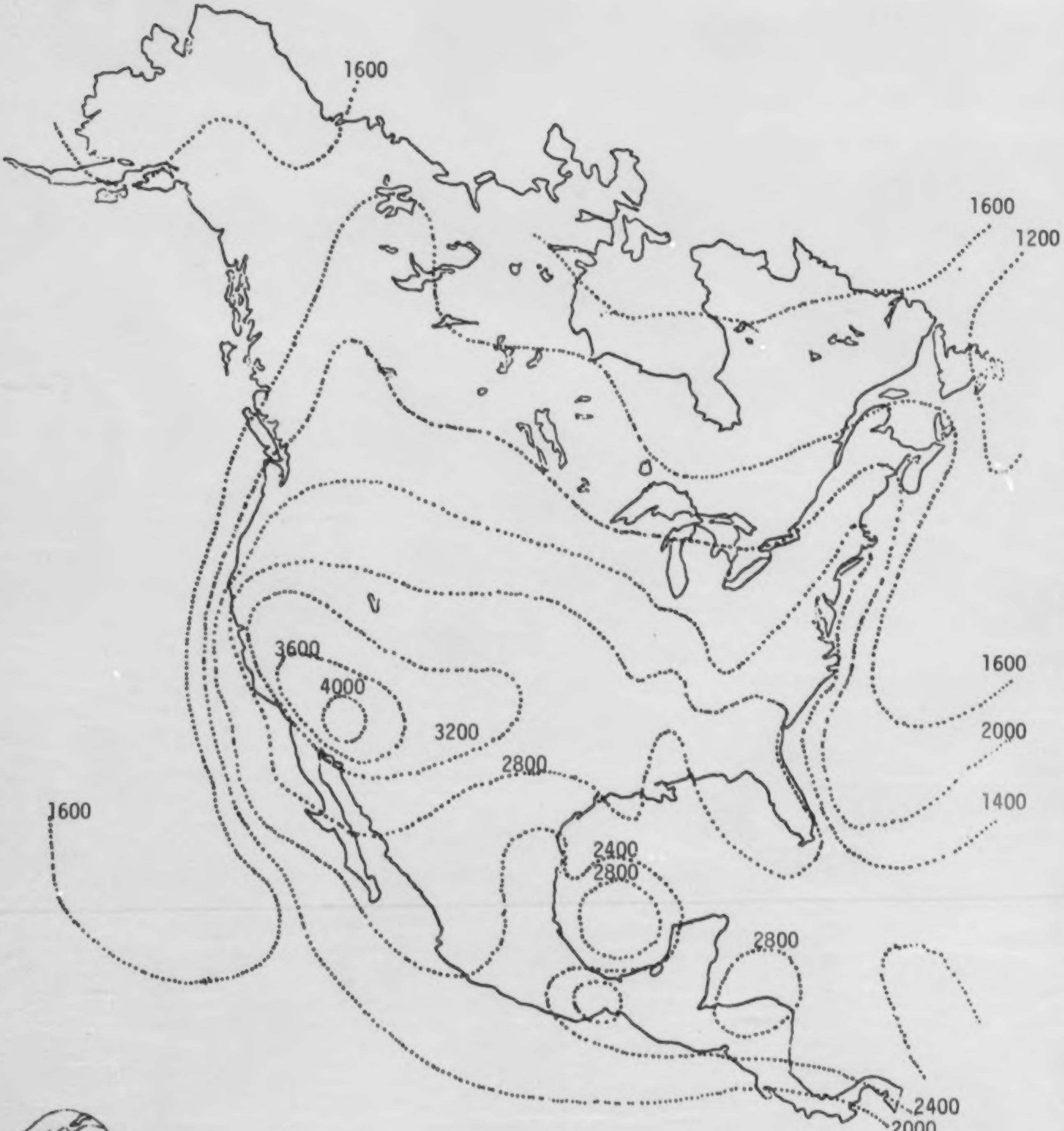
HOURS OF SUNSHINE

Per Year

Handout #13



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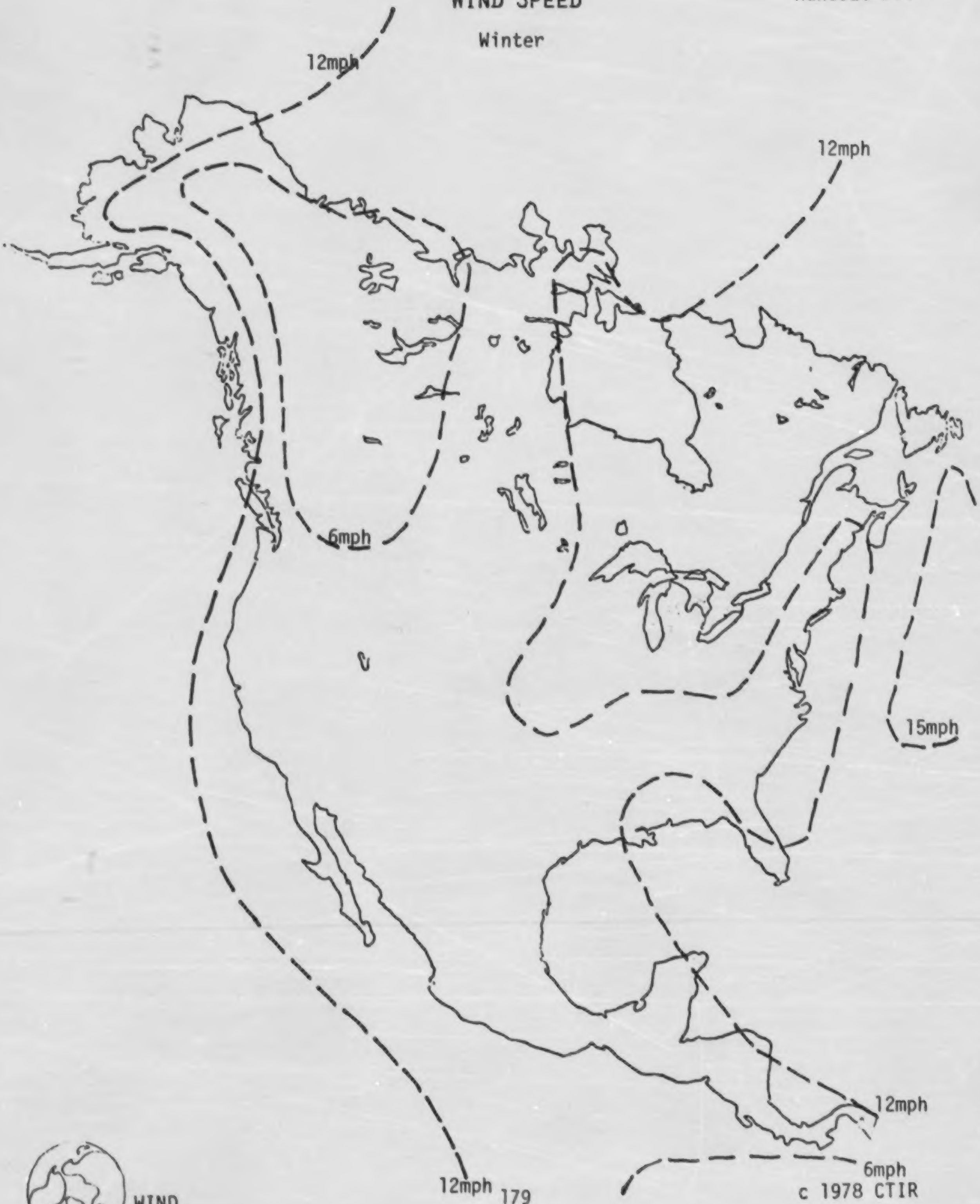
WIND SPEED

Winter

Handout #14



WIND

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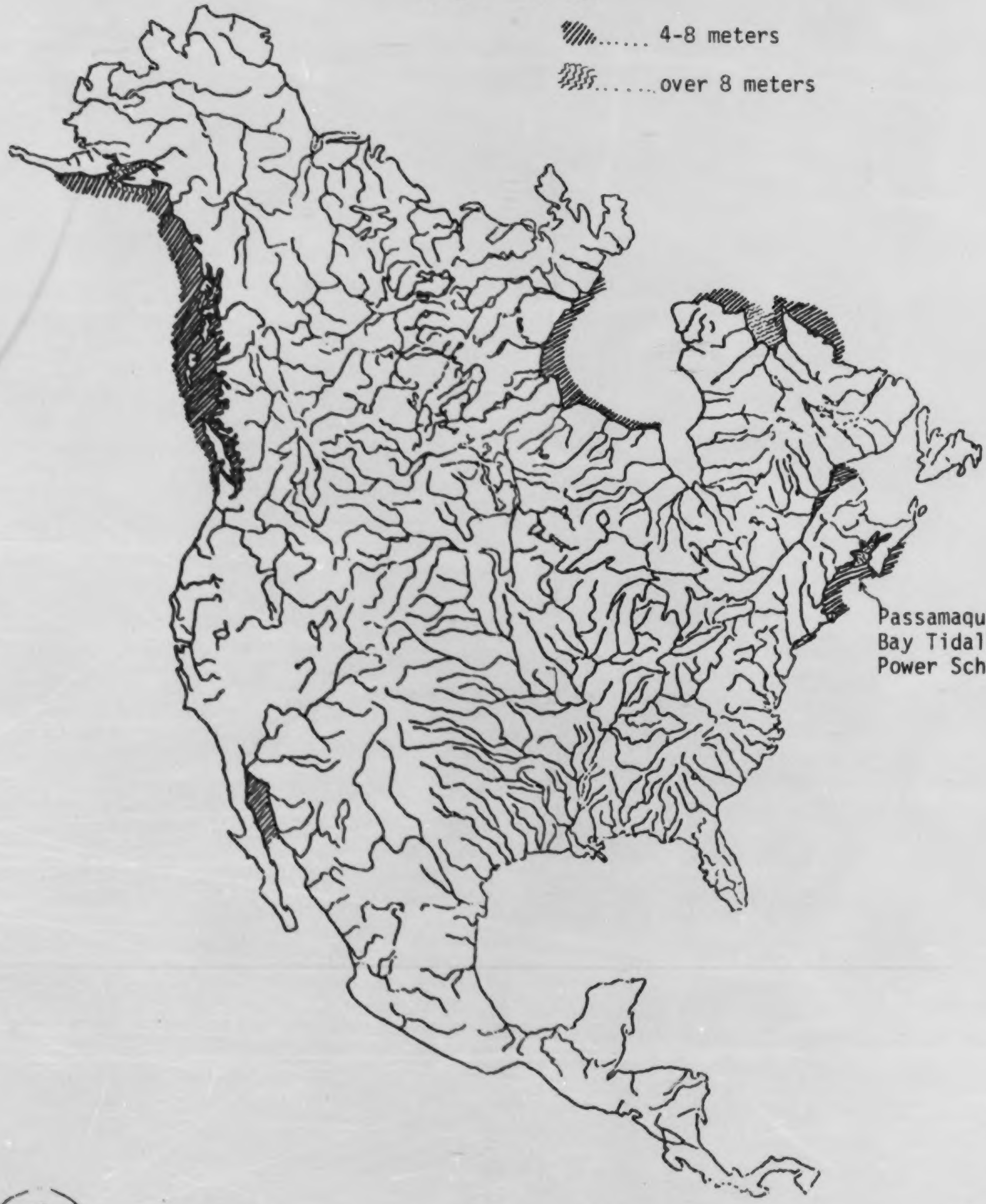
WATER

Handout #15

Rivers and Tide

▨...... 4-8 meters

▨...... over 8 meters



Passamaquaddy
Bay Tidal
Power Scheme

TIDE

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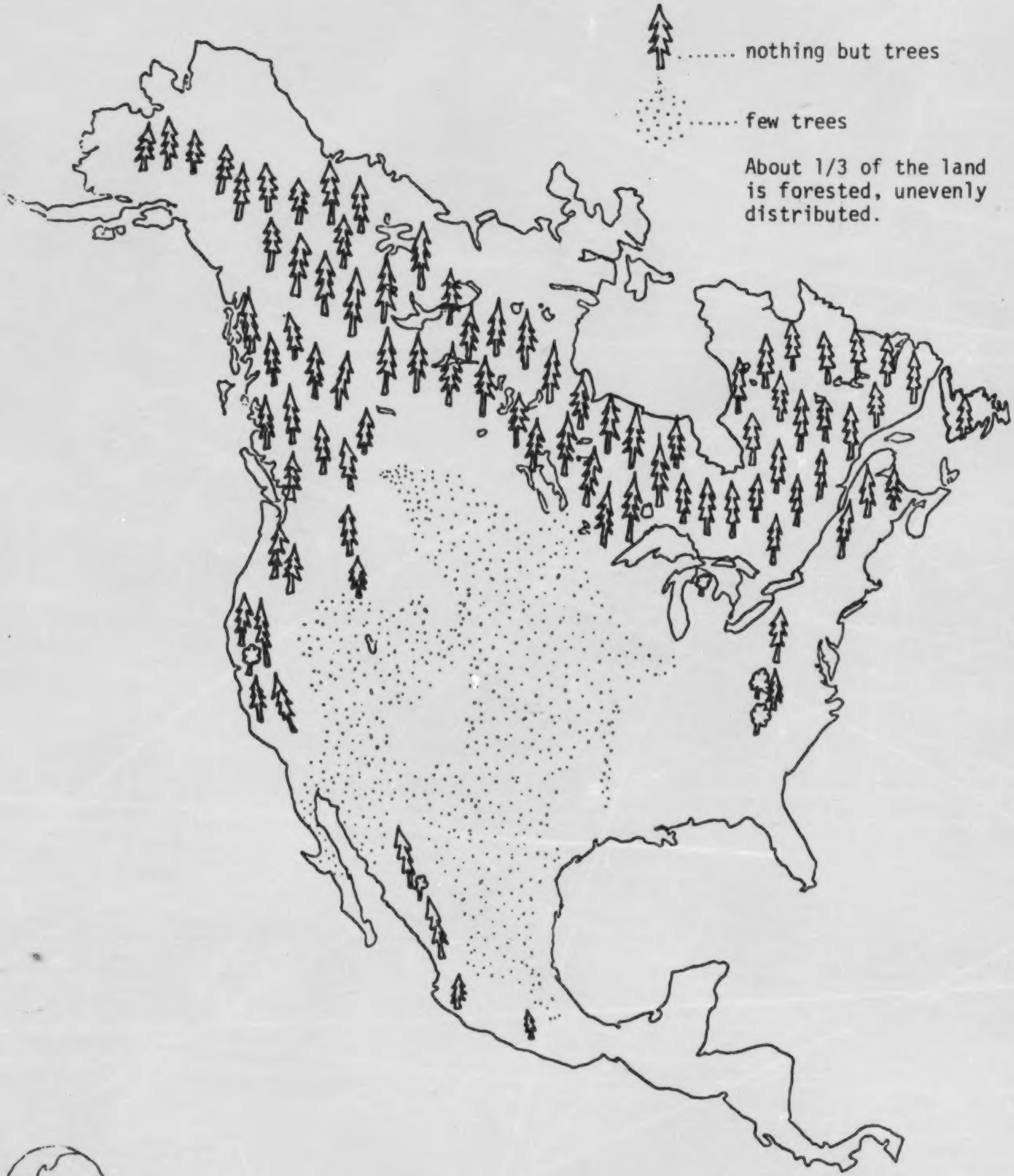
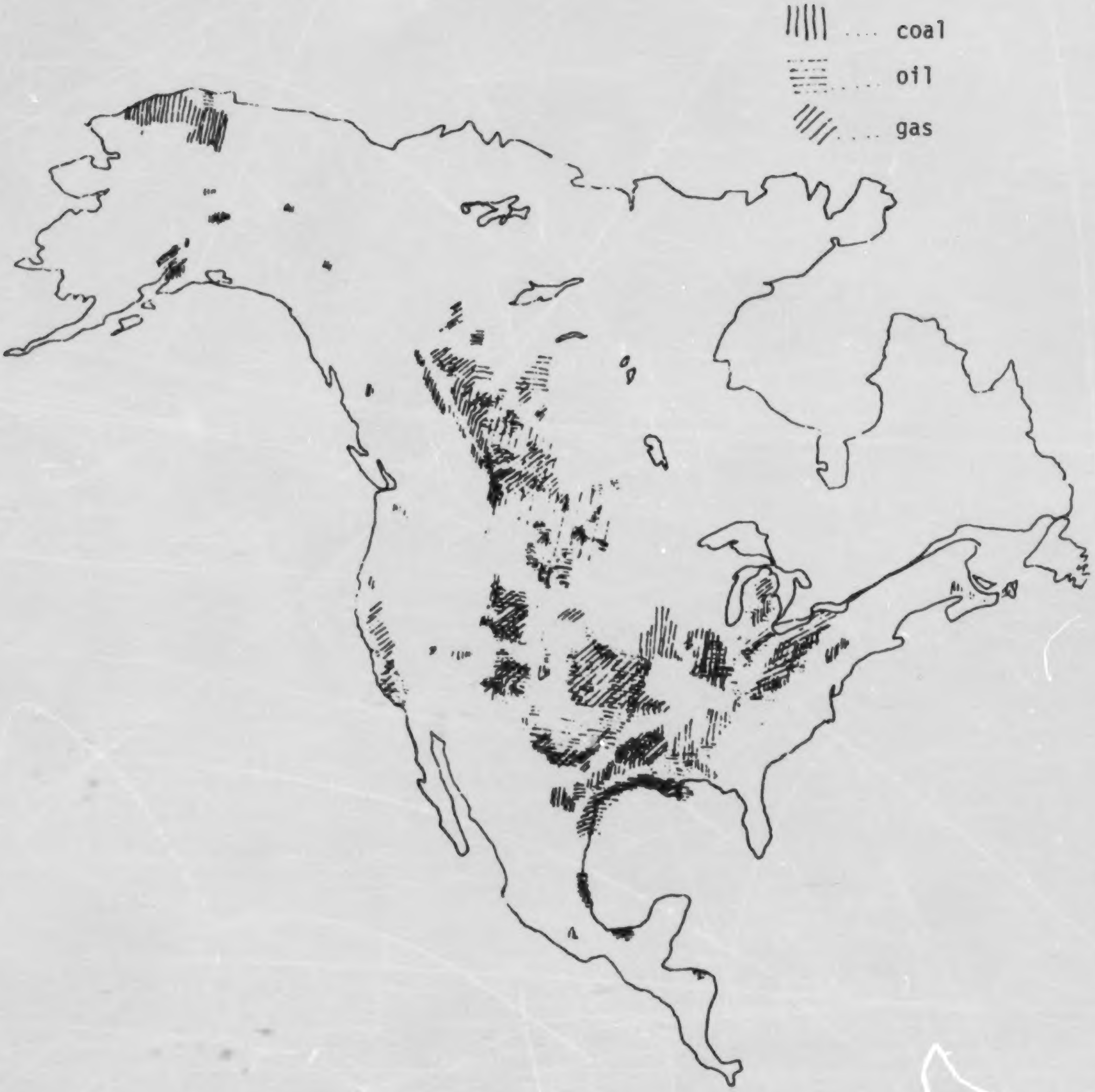
WOOD



About 1/3 of the land is forested, unevenly distributed.

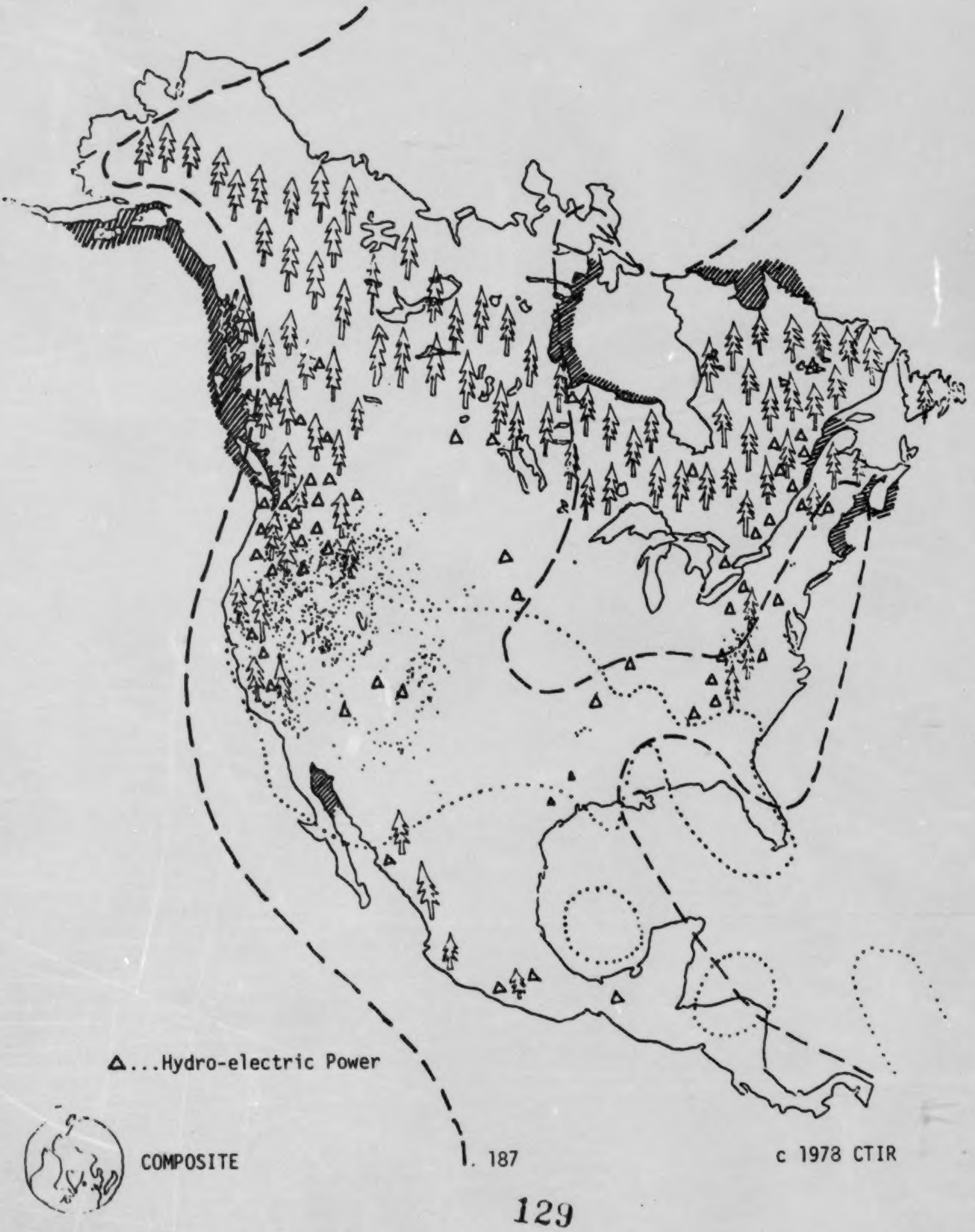
FOSSIL RESOURCES

Handout #17



COMPOSITE MAP

Renewable Energy Resources



COMPOSITE

187

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INTERCONNECTIONS

Handout #19

NOTE: More than one line may be drawn to any of the items.

More Pollution

More Buildings

More Hunters Coming Back

More Deaths

More Noise

More Factories

More Cards

More People

Less Animals

More Deaf People

More Dirty Air

Less Water

Less Gas

Less Hunters

More Hearing Aids

More Droughts

More Time for Animals to Grow

Less Trees

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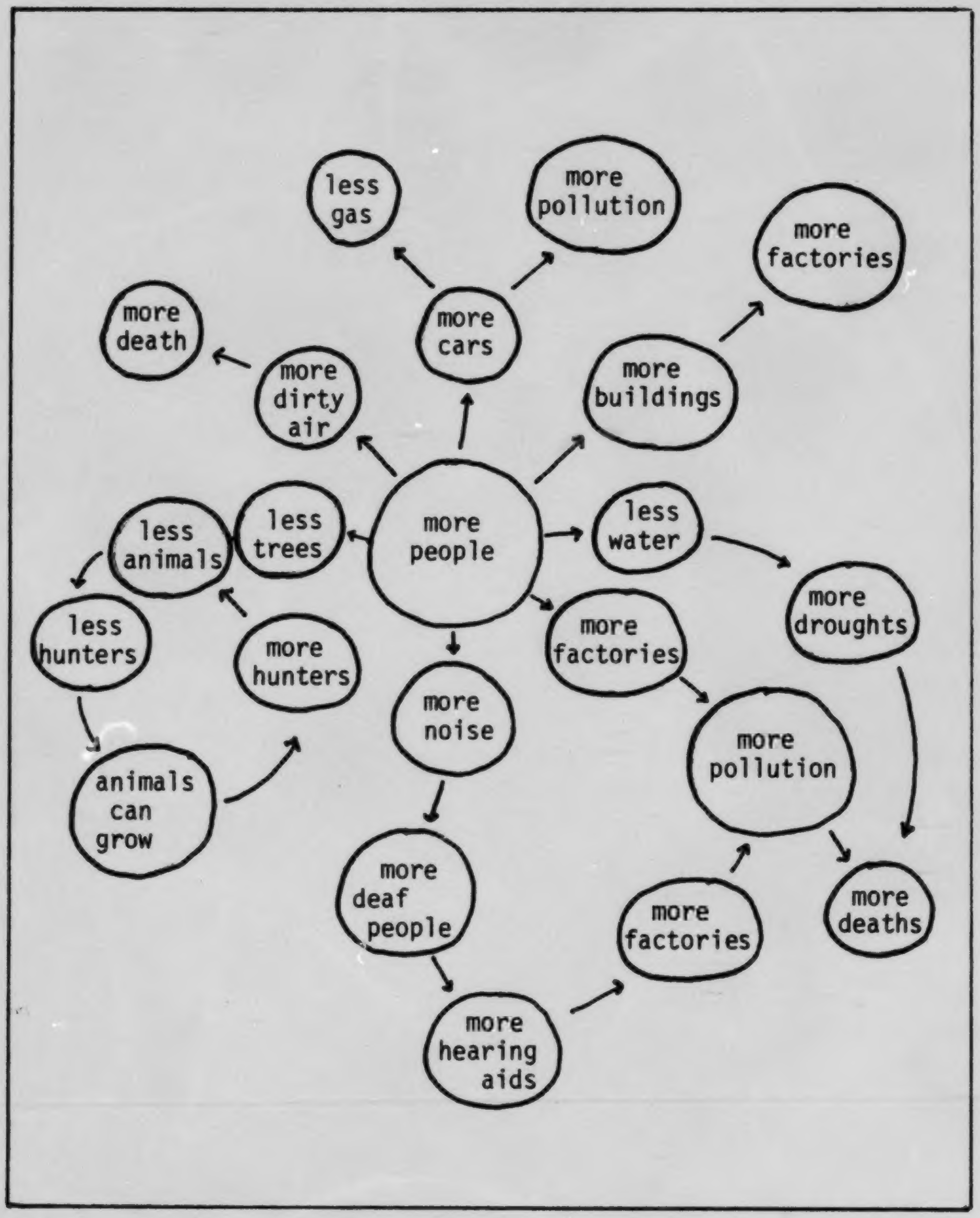
FUTURE WHEEL*

Handout #20



*From Growth Implications and the Earth's Future, Education Development Center, Newton, Mass., p. 79.

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Handout #21

CONSEQUENCES

PROBLEM?	SOLUTION	CONSEQUENCES
Example: Outdoor Plumbing	Flush toilets Sinks and drains	Waste treatment, use of a lot of water, etc.
1. Traffic congestion		
2. Water shortage		
3.		
4.		
5.		
6.		
7.		
8.		
9.		
10.		
11.		
12.		
13.		
14.		

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WHAT IS ENERGY?

Handout #22

Although we do not know what energy is, we do know that if we have energy we have the potential for some useful work. This is the origin of the often quoted definition of energy: "the capacity to do work." Physicists define work to be a push or pull (force) applied over a distance.* If we move an object like a piano across the floor against the force of friction, we are doing work. We are able to do this work because energy in our bodies changes form. As we change the form of energy, we can have it do work for us. Unfortunately, when the energy changes form not all of the energy changes into a form which is useful to us. When electricity flows through the filament of a light bulb, 90 percent of the electric energy is changed into heat; only 10 percent is changed into light. All the energy is accounted for, but only 10 percent is useful to us, so we say that the light bulb is 10 percent efficient. Some changes of energy are much more efficient than others. Chemical energy to heat is an example of an efficient change of near 90 percent. Changing heat energy into mechanical energy is theoretically limited to 50 percent. The remaining 50 percent is lost to the environment as waste heat. This energy is so diluted that it can no longer do work for us. With most devices, there is a possibility of increasing their efficiency, but there is a physical limit to the process.

---

* A force is measured in newtons in the language of physics and is equivalent to approximately ¼ pound force. If a newton moves 1 meter, the amount of work that is done is 1 newton-meter. This unit is used so often that it is given its own name: a "Joule" after P. Joule. The attached chart gives the relationships between Joules and other units of energy.

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WORKSHEET #1

DIRECTIONS: Write in each box examples of one form of energy being converted into another form and the efficiency of the conversion. Use Worksheet #2 to generate ideas and efficiencies.

TO FROM	HEAT Thermal	LIGHT Radiant	MECHANICAL Movement	CHEMICAL	ELECTRIC	NUCLEAR
HEAT Thermal						
LIGHT Radiant						
MECHANICAL Movement						
CHEMICAL						
ELECTRIC						
NUCLEAR						

Handout #23

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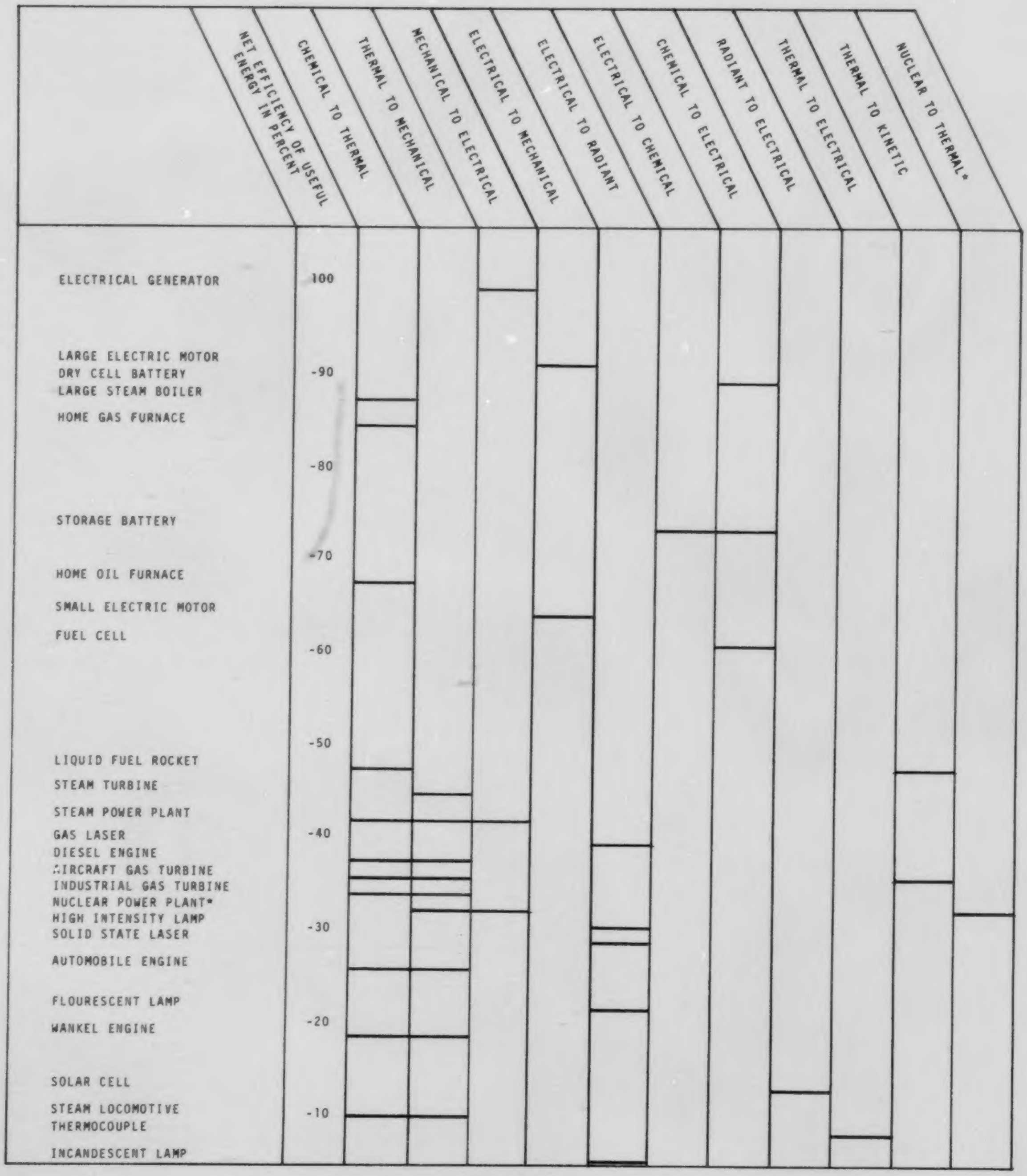
WORKSHEET #2


NET EFFICIENCY OF USEFUL ENERGY IN PERCENT
CHEMICAL TO THERMAL
THERMAL TO MECHANICAL
MECHANICAL TO ELECTRICAL
ELECTRICAL TO MECHANICAL
ELECTRICAL TO RADIANT
ELECTRICAL TO CHEMICAL
CHEMICAL TO ELECTRICAL
RADIANT TO ELECTRICAL
THERMAL TO ELECTRICAL
THERMAL TO KINETIC
NUCLEAR TO THERMAL*
ELECTRICAL GENERATOR
LARGE ELECTRIC MOTOR
DRY CELL BATTERY
LARGE STEAM BOILER
HOME GAS FURNACE
STORAGE BATTERY
HOME OIL FURNACE
SMALL ELECTRIC MOTOR
FUEL CELL
LIQUID FUEL ROCKET
STEAM TURBINE
STEAM POWER PLANT
GAS LASER
DIESEL ENGINE
AIRCRAFT GAS TURBINE
INDUSTRIAL GAS TURBINE
NUCLEAR POWER PLANT*
HIGH INTENSITY LAMP
SOLID STATE LASER
AUTOMOBILE ENGINE
FLOURESCENT LAMP
WANKEL ENGINE
SOLAR CELL
STEAM LOCOMOTIVE
THERMOCOUPLE
INCANDESCENT LAMP
100
-90
-80
-70
-60
-50
-40
-30
-20
-10

RESOURCE DEPLETION

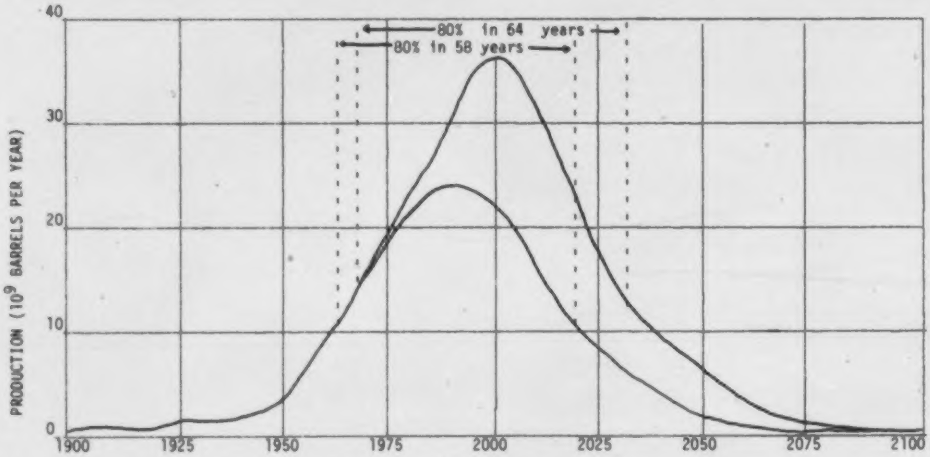
Handout #25

Name: ______________________________ Due Date: ________________

Purpose: To model the depletion of a natural resource, plot related graphs and interpret their meaning.

Background Information:

No natural resource is consumed at a constant rate. Instead, it usually goes through a production cycle that starts slowly, rises to a peak and then slowly diminishes as the resource is exhausted. Typical of this cycle is the history of oil. When oil was first discovered, its rate of consumption was very low. It was used as a lubricant and as a fuel for lamps. But as the years went by, people became more familiar with it and its properties. Its use expanded. Cars used it as their source of power and mass production made mechanized transportation possible for millions of people. The consumption rate, and hence, the production rate, rose exponentially. Then came the diesel locomotive, the airplane, trucks, asphalt, the motor cycle and minibike, heating oil, and the oil fired power plant. Exponential growth continued. But oil is a non-renewable resource, and the earth and its resources are finite. Hence, the production rate must eventually peak and then decrease, also exponentially. This is shown in the cycle of world oil production illustrated below.



CYCLE OF WORLD OIL PRODUCTION is plotted on the basis of two estimates of the amount of oil that will ultimately be produced. The higher curve reflects Ryman's estimate of 2,100 x 10^9 barrels and the lower curve represents an estimate of 1,350 x 10^9 barrels.

(From the Energy Resources of the Earth, M. King Hubbert. Scientific American, September, 1971, p. 69)

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Note that oil consumption exhibited a slow beginning during the 1880s, and a primary usage during the 1900s. Reserve estimates and human behavior patterns imply a phasing out in the twenty-first century. Although a certain amount of guessing goes into projecting the latter portion of the curve, the information is valuable in that it can help us plan for the future.

Since the beginning and end of any resource depletion curve are so indistinct, many experts talk about the 80 percent lifespan (see graph). This is the period of time during which 80 percent of a resource is expected to be withdrawn. Generally, when 90 percent of a resource is withdrawn, the resource is considered exhausted. The remaining 10 percent is just too expensive to extract.

After you do the activity and complete the graphs, compare your findings to the history of oil.

Assumptions:

1. The Earth and its resources are finite.
2. Demand for and consumption of our nonrenewable resources will continue to grow exponentially until they cannot any more.

Procedure:

The large box filled with styrofoam represents the earth. The styrofoam represents the material of the earth's crust--the dirt, the water, the minerals. The black pieces of styrofoam represent an ore--anything that is useful to man that can be extracted at a profit.

You and your fellow students will be the developers (the oil, coal, and mineral companies). Fifteen (15) seconds of digging in the box will represent one year of production. During the first year, one person will mine in the box. The production rate will be the number of nuggets (black styrofoam pieces) he (she) can find in one year (15 seconds). Because a profit was made, more companies become interested in exploration, so two persons mine the next year. Because profit was made and new uses for the resource were discovered, four persons mine the next year. The number of developers increases exponentially to eight, sixteen, etc., as long as profits can be made. Developers continue in business as long as they are able to net (after taxes) six nuggets/year. This is the minimum amount necessary to make a profit. Companies that are careless in their mining practices (as indicated by a mess on the floor) will be assessed an environmental damage tax which will be 20% of their total production that year (rounded off to the nearest whole nugget and never less than one). Continue resource depletion until the production rate drops to approximately what it was during the first year of development.

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Alternative Procedure:

Divide the class into groups of eight. Each group of eight will form its own nation with a unique name. During the first year, each nation gets to send one member to mine in the box for 15 seconds. Anyone who spills the styrofoam will be fined 20% of his take. During the second year each nation will send two miners to collect the resource. As the number of miners grows, it may become necessary to let the nations take turns in their mining.

After the third doubling (year of mining), announce that hereafter capitalist nations will not be allowed to exploit your natural resources for free. The nations must bid (using their styrofoam beads as money) for the privilege of going first and second each year. Continue doubling the number of miners or the time allowed for mining each year. When the number of beads harvested drops to less than six per year, discontinue all mining operations.

Each year each group records how many beads were mined. The data is then used to construct a resource depletion graph.

This alternative procedure requires a larger resource pool but the competition between groups adds interest for the students and gets more students directly involved in the activity.

Graphs:

1. Divide a sheet of graph paper in half. On the left half plot a graph of Rate of Withdrawal (Production) vs. Time. On the right half plot a graph of Total Amount Withdrawn vs. Time. Write a conclusion for each graph on the back of the graph paper and turn in the graphs and conclusions tomorrow.
2. Plot a graph of U.S. Crude Oil Production vs. Time (1925-1975) using the data provided on the following pages.

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DATA: Fifteen seconds in the lab = 1 year of production Handout #25

Time (years)	Number of Developers	Production - or - Rate of Resource Withdrawal (nuggets/year)	Total Resource Withdrawn (nuggets)
1	1		
2	2		
3	4		
4	8		
5	16		
6			
7			
8			
9			
10			
11			
12			
13			
14			

Notes: 1. Since sixteen people is about all you can crowd around the box, thirty-two people is equivalent to sixteen people mining for two years (30 seconds), and sixty-four is equivalent to sixteen people mining for four years (60 seconds).

2. Total resource withdrawal is an accumulative summation of all the nuggets withdrawn. Your final number will be very close to the total number of nuggets in the box.

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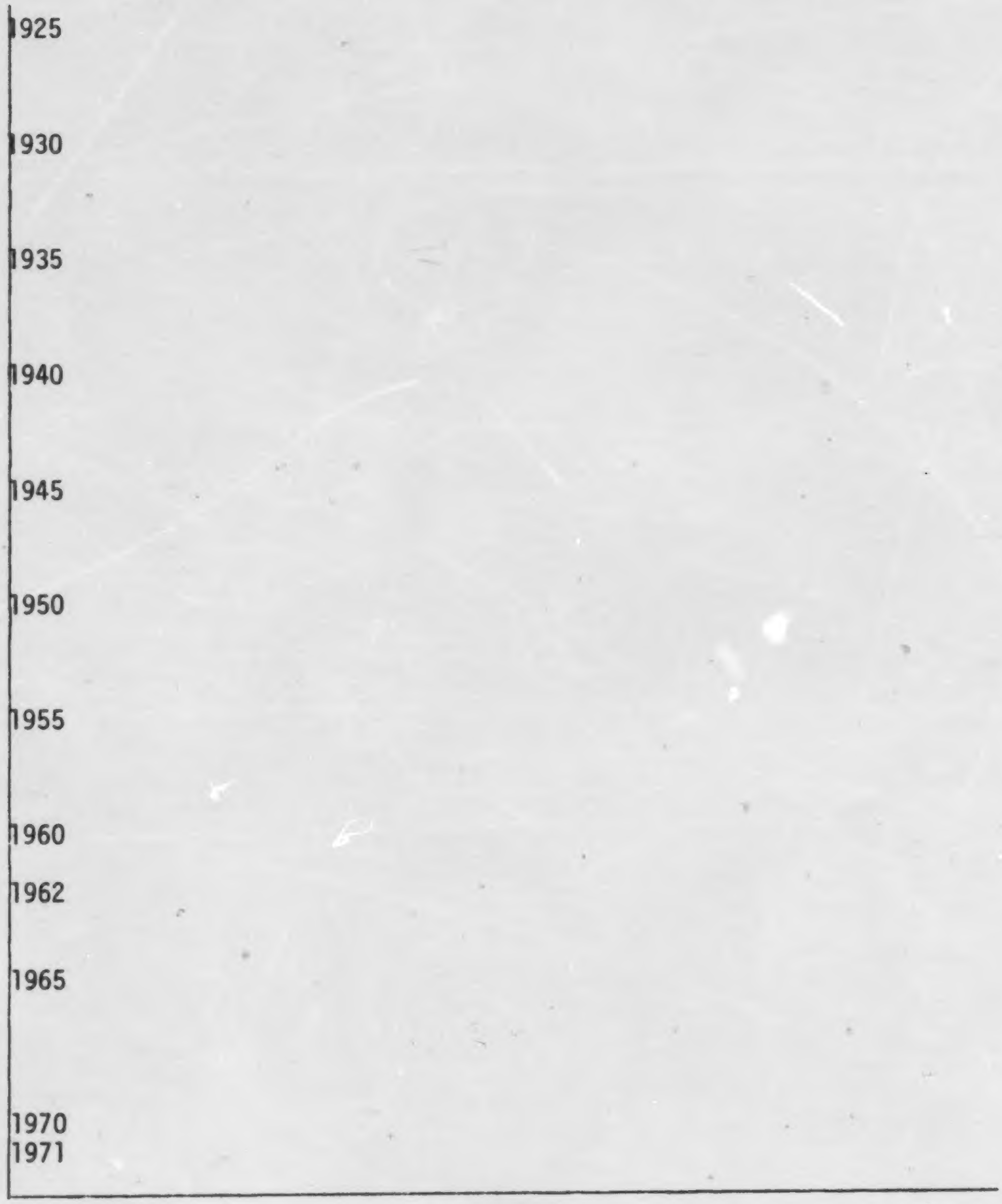
Handout #25

U.S. PETROLEUM PRODUCTION



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Handout #25

FIGURE 8.17

U.S. PETROLEUM PRODUCTION

Source: Bureau of Mines; in thousands of 42-gallon barrels

1925	763,743
1930	888,011
1935	996,596
1940	1,353,214
1945	1,713,655
1950	1,973,574
1955	2,484,428
1960	2,574,833
1962	2,676,189
1965	2,848,514
1970	3,517,450
1971	3,453,914
1972	3,455,368
1973	3,360,903
1974	3,202,585
1975	3,056,779

Complete cycle of crude-oil production in the United States and adjacent continental shelves, exclusive of Alaska.

*From Hubbert, M. King: "Energy Resources," Resources and Man, W.H. Freeman and Company, San Francisco.

Compare your graph to the graph and projection made by M. King Hubbert. Hubbert's projection (extrapolation) was made in the late 1960s. Does it seem realistic to you?____ In what year does he predict that approximately 90% of the petroleum reserves in the U.S. will be gone?____ How old will you be then?____years. How should we prepare for this possibility?______

Written by John W. Christensen for Project Physics, Inc. 12/29/77

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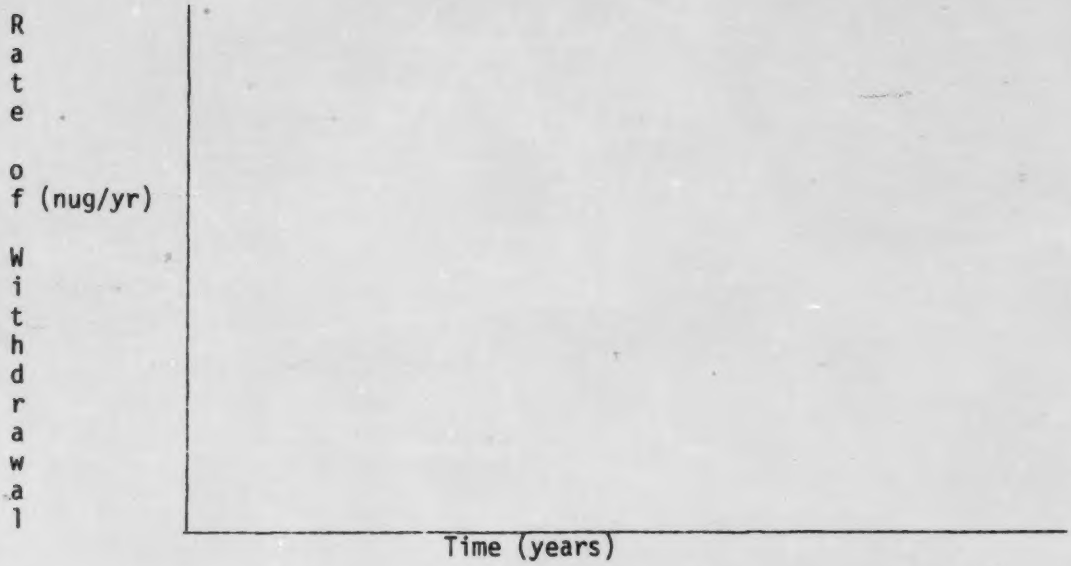
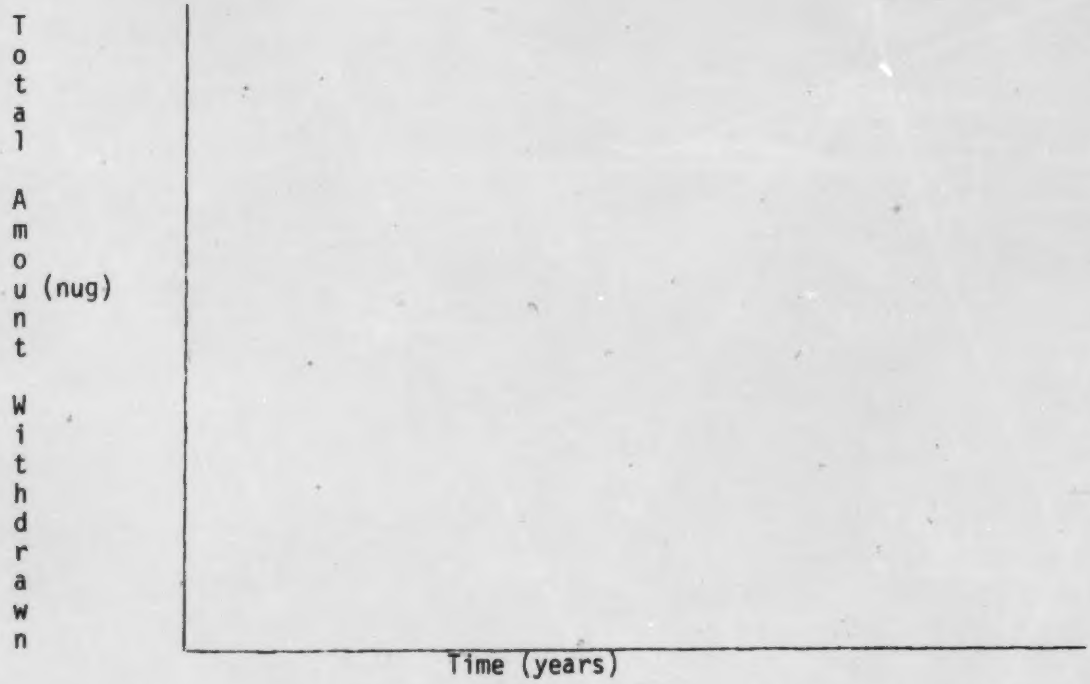
RESOURCE DEPLETION GRAPHS

Handout #25





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EXPONENTIAL GROWTH WORKSHEET #1

Handout #26

Using a Calculator to Compute Exponential Growth

To use percent growth rates on a calculator, change the % to a decimal and add 1. Complete the table.

Percent of Growth Rate	Decimal Rate	Each Year Multiply By
1) .8%	.008	1.008
2) 1.5%	.015	1.015
3) 2.0%	.02	1.02
4) 3.4%		
5) 1.0%		
6) .5%		
7) 2.2%		
8) 3.0%		
9) 2.9%		
10) 1.7%		

To find the decimal rate, take the % rate and move the decimal point two places to the left.

To find what number to multiply by, put a one in front of the decimal rate.

If your calculator has a memory, store the rate you multiply by each year so you will not have to punch it in each time.

If your calculator has a % key, you do not need to change the growth rate to a decimal. For instance, if the growth rate is 1.5%, enter the population and just punch $\boxed{+}$ $\boxed{1.5}$ $\boxed{\%}$ $\boxed{=}$ for each year of growth.

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Handout #27

EXPONENTIAL GROWTH WORKSHEET #2

Projecting Growth in Energy Consumption

In 1978 the United States used an average of 7.4 million barrels of gasoline per day. This use of gasoline was increasing at the rate of 3.3% per year. If this growth rate stays the same until the year 2000, how much gasoline would be needed per day in the year 2000? (3.3% = .0333. Start with 7.4 each year and multiply by 1.033)

Year	Millions of Barrels Used Per Day
1978	7.4
1979	7.4 x 1.033 = 7.64
1980	7.64 x 1.033 = 7.90
1981	7.90 x 1.033 = 8.16
1982	
1983	
1984	
1985	
1986	
1987	
1988	
1989	
1990	
1991	
1992	
1993	
1994	
1995	
1996	
1997	
1998	
1999	
2000	

Will the amount of gasoline used per day double by the year 2000?

Will there by twice as much gasoline available in the year 2000?

In 1979 the U.S. consumption of coal increased 5.5% over the previous year to about 658 million tons. Construct a chart like the previous one showing how much coal would be used each year until the year 2000 if the growth rate stays at 5.5%.

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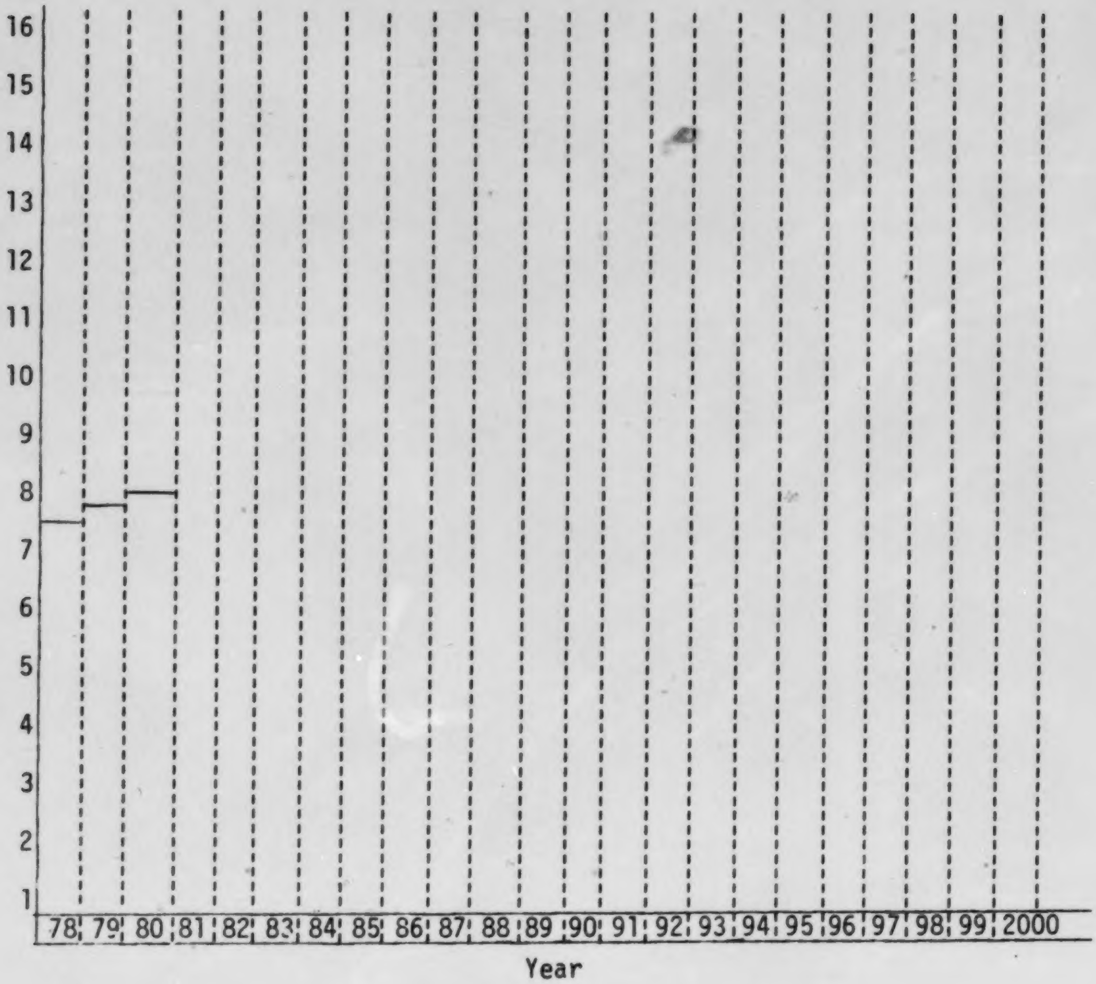
EXPONENTIAL GROWTH WORKSHEET #3

Use your results on worksheet #2 to finish this bar graph.



Growth in Gasoline Consumption Projected from 1978 to 2000.

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EXPONENTIAL GROWTH WORKSHEET #4

The Population Race

In 1979 Mexico's population was 67.7 million and the growth rate was 3.4%. In that year the population of the U.S. was 226.1 and the growth rate was 0.9%. If the growth rates remain the same, in what year will the population of Mexico surpass the population of the U.S.?

Use two calculators, one for you and one for your partner. Calculate the growth of the U.S. while your partner calculates the growth of Mexico. If you are calculating Mexico's population, start with 67.7. Multiply by 1.034 to simulate one year's growth. If you are computing U.S. population, start with 220.3 and multiply by 1.009 each year.

After each calculation compare answers. Keep track of the number of multiplications needed before Mexico passes the U.S. Write the year, the future population of Mexico in that year, and the population of the U.S. in that year.

1. Number of years for Mexico to pass the U.S. ____________

+ 1979

2. Year when Mexico passes U.S. ____________

3. Population of Mexico ____________

4. Population of U.S. ____________

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Handout #30

EXPONENTIAL GROWTH WORKSHEET #5
Finding Doubling Times on a Calculator

In 1976 the population of the world was 4.4 billion and the growth rate was 1.9%. If that growth rate continues, how many years will it take the world's population to double?

Enter 4.4 on your calculator. Repeatedly multiply by 1.019. Count how many times you have to multiply to obtain 8.8 or more in your answer.

- - - Doubling time = ____________ years

Doubling time depends only on growth rate. In 1979 the energy consumption growth rate of the United States was 2.4%. How many years will it take for the U.S. energy consumption to double if the growth rate is 2.4%?

Enter 1 on your calculator. Repeatedly multiply by 1.024. Count how many times you have to multiply to obtain 2 or more for your answer.

- - - Doubling time = ____________ years

Find the doubling times for the following growth rates.

Growth Rate	Doubling Time	Growth Rate	Doubling Time
.5%		2.5%	
1.0%		3.0%	
1.5%		3.5%	
2.0%		4.0%	

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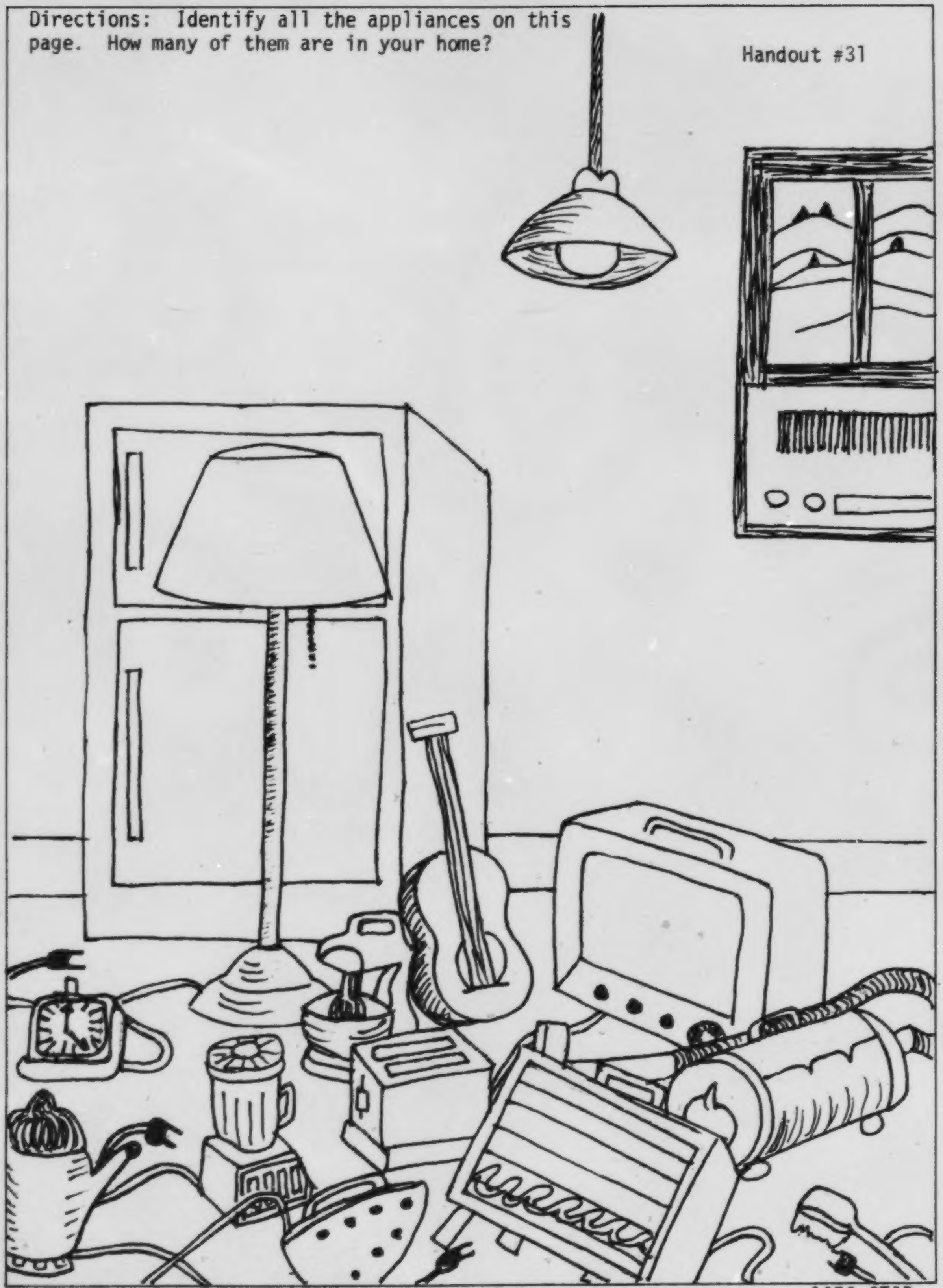
Directions: Identify all the appliances on this page. How many of them are in your home?

Handout #31



Cartoon from Education Development Center, Inc.
"What is Energy?" People and Technology (1973) p. 20

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ENERGY USING GADGETS

The average household has about 29 small electrical appliances that use almost 10% of the energy consumed in the home and cost us precious dollars to operate. Some of these gadgets are necessary and helpful in everyday living, but the majority are "convenience gimmicks" that are wasteful and inefficient. Simple tasks like carving meat, combing hair, brushing teeth, washing dishes, squeezing juice and opening cans should be performed with human energy and not electrical energy.

Directions

1. Count the number of electrical appliances in your own home._____
2. Create categories for your appliances (i.e., kitchen devices, gardening tools, entertainment, grooming appliances).
3. List your appliances in categories on the following page.
4. Do some research to determine the number of kilowatt hours each appliance consumes annually. A kilowatt hour is most often used when measuring electrical consumption in homes and factories. Example: a 100 watt bulb burning for 10 hours uses 1 kilowatt hour of energy.
5. Now, brainstorm a substitute for each appliance.
6. List the appliances that are used most frequently (i.e., on a daily basis.
7. List the appliances that are absolutely necessary.
8. List the appliances that you can easily do without.

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SURVEY OF ENERGY USING GADGETS

Handout #32

Energy Appliances in my House	Kilowatt Hours Consumed Annually	Substitute If you did not have it, what would you do or use?

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Handout #32

Electric Appliance	Kilowatt Hours Consumed Annually	Substitute
Blender	15	egg beater and strong arm
Carving knife	8	sharp knife
Coffee maker	106	do without
Dishwasher	363	wash dishes by hand
Egg cooker	14	cook eggs in boiling water used for tea or coffee
Garbage disposal	30	compost food waste
Trash compactor	50	manually shred trash and crush cans
Clothes dryer	993	hang clothes to dry outside in summer and inside in winter (to help humidify)
Iron	144	wear permanent press clothing
Electric blanket	147	sleep with extra blankets
Humidifier	163	put a pan of water on the radiator, hang up wet clothes, or open the bathroom door after a shower
Portable heater	176	heavier clothing
Hair dryer	14	dry towel, strong arms
Germicidal lamp	141	do without
Sun lamp	16	go outside and enjoy the sun
Shaver	1.8	grow a beard
Toothbrush	.5	brush by hand
Vibrator	2	physical exercise
Clock	17	wind-up clock
Can opener		manual can opener

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Handout #33

ENVIRONMENTAL IMPACT AND ENERGY

Rank the potential environmental hazard of the sixteen energy options listed as being low, medium or high in the four categories listed. When you finish, turn your results in to your teacher. You will need this ranking later when you try to anticipate your energy future.

Energy Options	Air Pollution	Water Pollution	Land Use Impact	Possible Large Scale Disasters
conservation				
coal				
new fuels from coal				
conventional reactors				
breeder reactors				
solar heating and cooling				
solar photovoltaic				

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Energy Options	Air Pollution	Water Pollution	Land Use Impact	Possible Large Scale Disasters
solar thermal energy conversion				
solar sea power				
controlled nuclear fusion				
geothermal energy				
wind power				
fuels from plants				
fuels from water				
oil shale				
tar sands				

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POWER SOURCES CONSERVATION

Handout #34

Description: The reason for the U.S. energy crisis is quite simple: demand for energy is increasing while supplies of oil and natural gas are diminishing and becoming more expensive. A major cause of that ever growing demand is our huge stock of capital goods--such as homes, cars, and factory equipment--that use energy inefficiently. This inefficient stock developed during the decades of the 1950s and 1960s when energy was so cheap that no one really thought about using it wisely. But times have changed and so must our patterns of energy use. Fully two-thirds of the energy America now consumes does no actual work. While half of that loss is the unavoidable result of physical limits to efficiency, much of the remainder is simple waste. America, which has about 6 percent of the world's population, consumes about 33 percent of its energy.

Energy consumption may be divided into three main groups: Industrial, Transportation, and Residential-Commercial. The use made of energy by each of these groups must be carefully analyzed to identify those areas to be targeted for energy savings. For instance, various U.S. industries have restructured themselves to become more fuel efficient in recent years, following the lead of their West European counterparts, who maintain a standard of living equal to ours. And we can learn more from their methods of operation. We know that probably the most significant factor in determining the gasoline mileage of an automobile is weight. We also know that an average new car in Europe weighs about 1900 pounds while in the U.S. it weighs about 3000 pounds. We also know that mass transit and rail transport are much more efficient than the private automobile. We know that space heating is the major category of energy consumption in homes and buildings and yet temperatures are maintained at unhealthy high levels in the winter and air conditioners run far too cold in the summer. Our pricing system is also out of line and fails to penalize waste. In the area of utility pricing, the smallest users commonly pay the highest unit price due to practices such as declining block rates. If we pay yesterday's prices for tomorrow's energy, United States resources will be rapidly exhausted. The pricing of oil and natural gas should reflect the economic fact that the true value of a depleting resource is the cost of replacing it.

Positive Features: Because we are rapidly running out of oil and natural gas, we must switch to the predominate use of other energy sources. However, the changeover from one energy source to another cannot and does not happen overnight. Conservation will help buy the time for making that transition and is also the most effective means of improving our supply-demand problem. It has been pointed out that a barrel of oil saved is as good as a barrel produced--but in many ways it is better. According to cost-effectiveness studies by the Federal Government, it costs only a tenth as much to save energy as to

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produce it. This is significant when one considers that our oil imports now account for almost half of our needs. Wasted energy--in cars, homes, commercial buildings and factories--is greater than the total amount of our oil imports. It is argued that a reduction of America's demand for world oil will be a form of assistance to the developing countries who so desperately need it.

Associated Problems: Conservation goes against the more-is-nicer, bigger-is-better philosophy we have operated with for so long. Although conservation measures are inexpensive and clean compared with energy production and use, they often involve sacrifice and are not always easy to implement. Smaller, lighter, less powerful cars mean a loss in some driving comfort and horsepower, but they do not inhibit our ability to travel. In summary, conservation may cause some inconvenience and require some sacrifice, but that is far more desirable than the projected drastic measures that will have to be taken in the future if we fail to act now.

Estimated Energy Available: The most recent scenarios indicate that energy demand in buildings could be reduced from today's level of 16.8 quads* to about 13 quads by the year 2000 if a fairly moderate conservation policy was implemented. This represents a reduction in energy use for buildings alone of almost 23 percent, and 3 to 4 percent of our projected total energy use (90 to 120 quads) in 2000.

Energy consumption from transportation is currently about 17 quads, and projecting today's practices into the future, the figure is expected to increase to 27 quads. Again, if a moderate conservation policy was implemented, it is estimated that transportation would consume only 17 to 20 quads by the year 2000. The automobile industry is already moving in this direction. New cars get a fleet average of 19 miles per gallon, as opposed to the pre-embargo (1973-1974) average of 11 mpg. Auto manufacturers believe that the standard of 27.5 mpg can be achieved by the imposed target date of 1985.

COAL

Positive Features: Of all the alternatives to the burning of oil and gas, coal offers the most immediate promise. This is because our needs are large and so are our coal reserves. Coal is the most abundant remaining fossil fuel that we have any real experience with. Most of our electric generating plants are already set up to run on coal, and electricity is a highly desired form of energy. Coal deposits are well mapped out, and we have the equipment to get at them.

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*A quad is a quantity of energy equal to the arithmetic value of 10^{15} British Termal Units (BTUs).

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Coal is also a very flexible energy resource. In addition to electricity, coal can be used to produce solid, liquid and gaseous forms of energy sources. Also, there are three basic varieties of coal: bituminous, anthracite, and lignite, which yield different amounts of energy, smoke, and useful after-products when burned.

Associated Problems: But with all these advantages, the large scale use of coal will cause major problems. Coal is difficult and dangerous to mine underground. Surface mining is both more economical and it is safer. However, water is very scarce in the West where almost all coal is surface (strip) mined. This makes land restoration costly and difficult. Coal is also the most polluting of the fossil fuels. Burning results in the emission of varying quantities of sulfur oxides and particulates. Increasing our use of coal for industrial, commercial, or residential purposes will require large new investments in pollution control equipment unless society is willing to accept dirtier air and more cases of respiratory disease. Finally the burning of vast quantities of coal will result in an increase in the carbon dioxide content of the Earth's atmosphere. Recently, there is growing concern that this may also contribute to the development of acid rain.

Estimated Energy Available: The United States has a total domestic resource of about 80,000 quads of coal. However, much of this supply is too expensive or too difficult to be mined profitably using conventional methods. This places the estimate for U.S. recoverable coal resources at 6,000 quads. A rough estimate for total world resources is about 300,000 quads. The U.S. currently consumes about 14 quads per year, or less than 3 percent of our recoverable reserves. In contrast, the U.S. currently extracts about 10 percent of its recoverable reserves of oil and gas each year. The National Energy Plan of 1977 projected coal production to double by 1985, but that estimate is now considered overly optimistic, as that goal will probably not be reached. Even if coal production doubled, our recoverable resources would last more than two centuries.

NEW FUELS FROM COAL

Description and Positive Features: About 90 percent of the nation's fossil fuel reserves are coal; however, most of the nation's cosumption (about 76 percent) involves oil and gas while coal represents only 18 percent of the total.

To reverse this trend while maintaining high environmental standards, the U.S. could possibly convert some of its vast coal reserves into clean, gaseous, liquid and solid fuels suitable for power generation, transportation, residential and industrial uses.

Both coal gasification (conversion of coal to gas) and liquefaction (conversion of coal to liquid and solid fuels) involve high temperature and pressure. Since coal is essentially a form of carbon containing only a small amount of hydrogen, the addition of hydrogen is required to make synthetic hydrocarbons.

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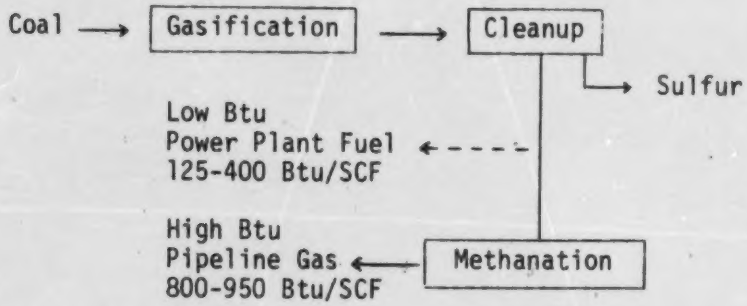
Coal can be converted to three types of gas:

1. High-Btu (or high energy) gas which can be directly substituted for natural gas
2. Medium-Btu (or high energy) gas which can be used for:
   a. utility boilers
   b. industrial fuel
   c. chemical feedstocks
3. Low-Btu gas for electrical generation



The major steps in the coal gasification processes are shown in the diagram. For high Btu gas, the three major steps of gasification, cleanup and methanation are involved. The various processes under commercial development differ in method, temperature, pressure and other conditions in accomplishing these three steps. Low-Btu gas can be obtained by eliminating the methanation step and the use of air rather than oxygen in the gasification step. The state-of-the-art in coal liquefaction in the U.S. is not as well developed as that of coal gasification; however, technology should be available by the early 1980s. Coal liquefaction has two advantages over coal gasification:

1. Petroleum substitutes produced from liquefaction can be transported by more means immediately into the wide spectrum of petroleum needs.
2. Gas is produced as a byproduct when producing liquids and solids from coal.

Plants can produce as much as three barrels of synthetic liquids per ton of coal processed. The first gasification and liquefaction plants are expected to be in the West or Midwest, near the more accessible and cheaper coal reserves, but some early plants could be on the East coast near Appalachian coal fields.

Associated Problems: Environmental problems have dampened some of the enthusiasm for gasification and liquefaction. Large quantities of water are consumed in both of these processes. As a rule of thumb, about 1.5 to 3 pounds (or about 2 quarts) of water are required for each pound of coal processed. This is about twice the needs of an electric power plant of the same energy output. Since much of the coal to be gasified is located in the semi-arid West, this is a major problem. Also, some water

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needs disposal, and this water must be treated. Recovery and treatment systems will also be needed to minimize air pollution. Large quantities of solid waste such as sulfur and ash will require disposal. Then, there is the whole net energy question. It takes energy to grind up coal and then change it to oil and gas. Does enough energy remain in the final product to justify the whole process? Finally, a new and different worry for the synthetic fuel industries has recently surfaced. It has been known for some time that at the high temperatures used in these coal conversion processes, molecules known as "polycyclin aromatic hudrocarbons," PAH, are formed. There is ample evidence that many of these PAHs are carcinogenic, that is, cancer-causing. This problem has so far not been publicly addressed by the proponents of a coal-based synthetic fuel industry.

Estimated Energy Available: Obtaining significant amounts of energy from synthetic fuels is years away because of the lead times involved in constructing operating commercial plants and some remaining technological difficulties. The long range goal is to use the process to produce 14 of the 100 or so quads of energy we are expected to use in the year 2000.

CONVENTIONAL NUCLEAR REACTORS

Description: The nucleus of an atom is best examined or probed by shooting "bullets" at it. The best bullets for probing the nucleus are neutrons because they have significant speed and mass when they are produced, and because they have no electric charge. Their lack of charge enables them to move toward a nucleus completely unopposed by an electrical effect. What usually happens when a material is bombarded with neutrons is that the bombarded nuclei absorb neutrons, emit alpha, beta, or gamma rays and become different materials. However, when uranium-235, plutonium-239 or uranium-233 are bombarded with neutrons, their nuclei fission (split) into two parts of approximately equal mass. This process releases a huge amount of energy and it is also accompanied by the release of two to three neutrons per fission. Each new neutron can, if properly slowed down by a "moderator," cause another nucleus to split, releasing more energy and still more neutrons. Under certain conditions, a chain reaction is possible in which one neutron produces two which produce four which produce eight, etc. In each fission, huge amounts of energy are released and so a nuclear explosion (a bomb) occurs. If, on the other hand, you control the growth in the number of neutrons (using control rods), you have an energy source that can be used to produce electricity. The heat released in the reaction can be used to boil water or some other liquid. The resulting steam can turn the turbine in a conventional generator.

Positive Features:

1. A significant amount of energy is available to us in the form of nuclear energy.

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2. We know how to build and operate ordinary fission reactors. We have been doing this for many years.
3. A significant shift to nuclear energy will reduce our country's dependence on foreign sources of petroleum-based products.
4. Considering that fission-produced electricity is a complicated new technology, our conventional nuclear reactors have operated reliably and, considering the dangerous materials they use, quite safely.
5. Government studies have concluded that fission power plants have a favorable net energy yield, although some experts maintain that these calculations may not include all of the energy inputs to the system.

Associated Problems:

1. The fission process consumes uranium and thorium-based nuclear fuels. A significant shift to nuclear power would result in our using up our nuclear reserves in a relatively short time (20-50 years). If our uranium-235 reserves are consumed before our breeder program gets off the ground, then we theoretically lose the energy stored in 99 percent of our uranium reserves.

2. The fission process produces long-lived radioactive wastes that are a health and environmental hazard. At the present time we do not know how to safely store these wastes, which raises the ethical problem of passing them on to future generations.

3. A shift to nuclear energy would initially reduce our dependence on foreign petroleum products, but it may soon result in a new dependence on foreign sources of uranium and thorium, if our reserves of those fuels are as scarce as some estimates claim.

4. The disposal of heat produced by nuclear reactors is a serious thermal pollution problem. Expensive cooling towers and cooling ponds that dissipate heat out into the atmosphere must be constructed at the reactor site to minimize the environmental impact of such large-scale heat disposal.

5. Safety and the adequacy of future fuel supplies are the subject of an emotional national debate. The debate itself makes the whole future of nuclear power uncertain.

6. Safeguarding our supplies of nuclear materials is also a volatile issue. How to protect them from terrorist use and how to maintain accurate accounts of nuclear stockpiles are serious questions, presently without clear answers.

Estimated Energy Available: It is difficult to estimate the amount of energy available from nuclear sources because the numbers and the projections keep changing and the topic is so controversial. Published estimates vary considerably depending upon the orientation and vested

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interests of the research group. However, whether we like it or not, it seems certain that nuclear energy will play a role in providing for our energy needs for the next decade or two. Nuclear reactors could produce more than 20 percent of our electrical energy by 1990.

Uranium fuel production begins with a search for ore (that which can be mined profitably). The extracted raw ore is then milled or concentrated to a product called "yellowcake" which is 80 to 90 percent uranium oxide (U_3O_8). Resource estimates are given in terms of tons of yellowcake and are distinguished both by the production cost (in dollars per pound) and by how well assured we are of potential discoveries. For example, estimates of reserves range from 290,000 tons ($15 per pound) to 2.4 million tons ($50 per pound reserves plus probable potential reserves).

As of October 1978, 71 conventional nuclear reactors were contributing 52 gigawatts* of generating capacity (about 13 percent of the nation's electrical power). It is unclear how many conventional nuclear reactors we will have operating in the future. Construction of new plants has been offset by cancellations and deferrals of previously planned reactor sites. However, there seems to be some consensus on the estimate that at today's level of electrical production, our proven reserves of nuclear fuels will be depleted very early within the next century. If the U.S. makes a commitment to developing breeder reactors to replace our conventional ones, our reserves would last 60 to 100 times longer.

BREEDER REACTORS

Description: The uranium-235 isotope, which is the fuel in a conventional nuclear reactor, is the rarer of the two main isotopes of uranium. The most common isotope, uranium-238 (99.3 percent of all our uranium supply) cannot be used to maintain a fission chain reaction. But by allowing the uranium-238 to take up some of the spare neutrons in a reactor, it will eventually be changed into the isotope of another element, plutonium-239. This isotope can be fissioned by neutrons just like uranium-235 and can be used to produce heat in a reactor.

By absorbing neutrons, the common isotope thorium-232 can be changed, in a similar way, to form uranium-233. This isotope can also be used to sustain a neutron-caused chain reaction.

It is beyond the scope of this unit to discuss reactor design, fuel rod fabrication, breeding ratios and spent fuel rod processing. Suffice it to say that by careful selection and arrangement of materials in a reactor, the neutrons not needed in the fission chain reaction can be used to convert U-238 and Th-232 into Pu-239 and U-233. Thus scientists and engineers hope to be able to make use of most of the uranium and

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*One gigawatt of electricity (GWE) is equal to 10^9 watts, or 1,000 megawatts.

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thorium in nature for the release of nuclear energy and the production of electric power.

Positive Features:

1. A significant amount of energy is available to us in the form of nuclear energy--especially if the breeder program becomes a reality.
2. A significant shift to nuclear energy will reduce our country's dependence on foreign sources of petroleum-based products.
3. Because breeders make nuclear fuel as they run, they will greatly extend the lifetime of our nuclear fuel reserves.

(NOTE: Thorium is several times more abundant than uranium, but statistics are inexact because even today there is no thorium mining industry. Without the breeder, we would reach the bottom of our nuclear fuel reserves early in the next century. Breeders can postpone that day for a long time--500 to 1000 years?)

Associated Problems:

1. Like ordinary fission reactors, breeder reactors produce long-lived radioactive wastes that are a health and environmental hazard. At the present time we (the people, the government) have not agreed on a method to store those wastes.

2. Like ordinary fission reactors, breeders produce large quantities of "waste" heat--which implies a potential thermal pollution problem.

3. The fissionable materials produced in a breeder should be used to power new breeder reactors. However, since they are fissionable, they can also be used to make nuclear weapons. Clandestine bomb-making and blackmail by radical groups is not out of the question. Trucks hauling spent fuel rods can be hijacked. Any country that has the capability of producing plutonium-239 or uranium-233 also has the capability of become a nuclear power--as India demonstrated. The more than occasional success of undertakings by terrorists and other fanatic groups adds to our worries.

4. The plutonium-239 problem: Plutonium-239 is radioactive and an alpha emitter. If inhaled into the lungs, it can cause intensive damage in the tissue and cause cancer. Plutonium has been termed the most dangerous substance known to man. Where plutonium is used, we must not only minimize leakage, we cannot permit it at all.

Estimated Energy Available: If the U.S. makes a commitment to developing breeder reactors to replace conventional ones, the uranium resource base could last several hundred years instead of 20 to 50 years. This would certainly give plenty of time to develop the technology to exploit inexhaustible or renewable energy sources. However, the fears related

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to the health and safety hazards that may be associated with breeder reactors have led to many delays in their development in this country. Against President Carter's objections, Congress has allowed construction of our Clinch River breeder reactor to begin. The plant will be of intermediate size relative to its overseas counterparts, and is not expected to be operational until 1986 at the earliest. Hence, with all of the energy available, it could be that in the year 2000 we will be receiving very little energy from breeders. In the near future, little hope exists for breeder reactors to significantly alter the nuclear waste disposal problems inherent in our conventional plants.

SOLAR HEATING AND COOLING

Description: On the average, enough solar energy strikes the roof of most American homes to provide for all or a very significant portion of their total heating needs. This is true throughout the entire year. Basically, an active solar heating system works like this:

1. Collectors are installed, usually on the roof or ground near buildings, to absorb the sun's rays. A collector is usually a black plate covered on the sun side with transparent glass or plastic. An air space exists between the cover and the black plate. Black is used because it is an efficient absorber of sunlight. The transparent covers trap heat in the collector much like glass does in a greenhouse.

2. Water or air is circulated (usually in pipes) through the collectors to absorb captured heat and carry it to a storage tank (usually in the basement).

3. If air is circulated, the heat is stored in hot rocks. If water is circulated, the storage tank is usually a large tank of water. Fans or pumps are used to deliver the heat to the various rooms of the house.

A passive solar heating system is one in which there are no storage tanks, fans or pumps. Instead, the home is custom-designed to allow the sun's rays to enter the house through windows in the winter and prevent the sun's rays from entering in the summer. This is usually accomplished by using overhangs or by recessing the windows. If the home is well insulated and if the climate is generally sunny, this concept works very well.

Solar Cooling: At first it sounds impossible to consider using solar energy to cool a house. But the same principle behind the operation of our household refrigerators can be adopted to using the sun for cooling. A refrigerator is a "heat pump." Heat is transferred by exposing an expanded and, therefore cold, gas to the cool interior. This gas then flows to the outside coils where it is compressed so that its temperature increases. The heat is radiated (discharged) into the kitchen. In an electric refrigerator, pumps and compressors are used. In a solar cooling system, solar heat drives a vapor out of a liquid which expands, cools and picks up heat. It is then reabsorbed in the liquid to carry the heat away. The major difficulty with solar cooling units of this type is that temperatures of 200 degrees Fahrenheit or higher are needed. Since flat plate collectors cannot easily produce temperatures higher than 150 degrees Fahrenheit, some kind of concentrator (such as a parabolic mirror) is needed.

Advantages: Solar energy is our most abundant and available source of energy. It is a sustainable resource. It does not pollute the environment or produce dangerous waste products. Solar collectors can be used independently of central electric power generating stations. There are no foreseeable shortages of the basic materials needed for the widespread use of solar heating systems. Solar energy cannot be embargoed.

Disadvantages: The initial costs for putting in a solar heating system are now (1980) very expensive. It is hoped that early in this decade the costs (when spread out over 20 years) will be competitive with other types of heating. Because sunshine is unpredictable in many parts of the country, storage must be provided. To keep costs down, the storage is usually only enough for two sunless days. After that an auxiliary heating system must be used which adds to the expense. Presently, the U.S. lacks the comprehensive infrastructure needed to produce solar energy systems in large quantity, as the industry is still in its infant stage.

Estimate of Available Energy: In the South and Southwestern portions of the U.S., enough solar energy falls on the roof of the average home to take care of the total heating requirements during the winter months. Even in the Midwest and New England states, solar energy can provide more than half of the energy needed for winter heating. As conventional fuel costs rise, it will become economical to use solar energy for heating in the North as well as the South.

ELECTRICITY FROM THE SUN I
(Solar Photovoltaic Energy)

Description: Solar radiation can be converted directly to electricity in a solar cell. These little devices utilize the "photovoltaic effect." Photons, the little particles which make up a beam of light, if they carry enough energy, can knock electrons loose from the atoms they strike. Solar cells combine this property of light with the unusual properties of a semiconductor. A semiconductor consists of a junction between two dissimilar materials. A typical arrangement is shown on the following page:

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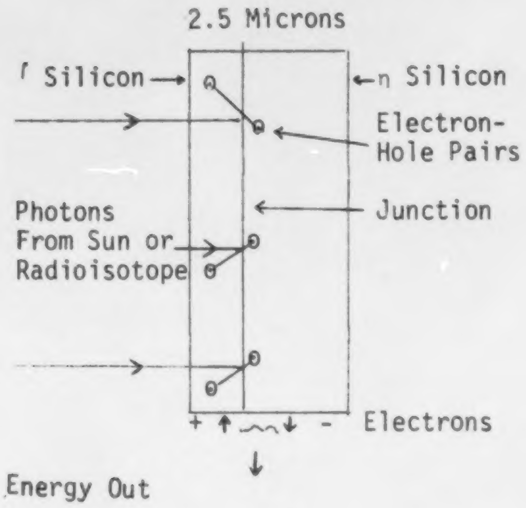

The p-region is transparent to light and very thin. Photons of light entering this region release electrons from the silicon atoms. The electrons flow in one direction across the junction and the holes move in the other direction. This sets up a potential difference, a voltage, and if circuitry is provided as shown, current will flow, electrons toward the positive terminal and holes in the opposite direction, and electric power will be available.

Positive Features: Solar cells have been used for years to power space vehicles, highway call boxes, offshore buoys and other devices which, because of their isolation are difficult to fuel in any conventional way. Once installed they essentially require no maintenance.

The chief barrier to widespread use of solar cells is cost. However, research breakthroughs and mass production should lower the cost significantly making photovoltaics commercially competitive.

Associated Problems: Solar cell arrangments with large capacity for electric power production can be constructed. 1000 watts or 1 kw is enough power for most household needs. The average commercial price for such an arrangement was about $15,000 in 1977. Even with skyrocketing costs, conventional power plants can produce electricity for less than $1,000 per kw.

Other than cost, the largest problem associated with the use of solar cells is the large amount of land they take up. One method suggested for eliminating this problem is to build satellite solar power stations in space. Since the satellite could receive sunlight continuously, it would receive about seven times as much solar energy as an Earth-based panel. The electric energy would be converted to microwave radiation and beamed to Earth where it would be collected and reconverted.

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Estimated Energy Available: The Department of Energy's goal for 1982 is to produce photovoltaic electricity for $2000 per kilowatt. One of the largest barriers to getting power from the sun seems to be lack of federal funds. It is widely believed within the solar industry that the competitive $1000 per kilowatt price could be achieved very soon if some of the $2 billion slated for the Clinch River Breeder Reactor went into solar research and development. The most optimistic projections indicate that the cost of solar electricity may be reducible to $500 per kilowatt by 1985. Consider also that the estimated cost for electricity generated by the Clinch River reactor is $5000 per peak kilowatt.

ELECTRICITY FROM THE SUN II
(Solar Thermal Energy Conversion)

Description: Solar thermal energy conversion is a collection system that concentrates enough sunlight onto a boiler or a fluid (example: water or heat-conducting oil) to create temperatures high enough in heat quantities sufficient enough to make large quantities of steam. The steam in turn is used to spin a turbine which rotates the coil of a generator which produces electricity. Two methods for doing this are being extensively researched. The first method is called the distributed collector concept. In its most common form, a long reflecting trough with a parabolic cross-section concentrates solar energy onto a collector tube through which flows a heat-conducting oil. In a heat exchanger, the oil transfers its heat to water to produce steam. Excess heat is stored for use at night and while the sun is not shining. The second method seems even more promising because of the higher temperatures achieved. In this concept, a field of computer-guided mirrors track the sun and focus the sun's rays onto a boiler which is mounted on top of a central receiving tower. Here the radiant solar energy is absorbed and used for the production of steam.

Positive Features: The main advantage, of course, is that sunshine is free and infinitely renewable. In addition, the environmental impact of these systems is relatively minor, with the potential local climatic effects causing the most concern.

Associated Problems: Only direct sunlight is usable, thus restricting solar thermal power plants primarily to the sunny areas of the country. There are no basic technical limitations in this method. The main questions are overall efficiency and economics. One key consideration is space. Sunlight is diffuse and must be collected over a wide area. It is estimated that in the Southwestern part of the U.S., approximately 26 kilometers (10 square miles) would be needed to operate a 1000 megawatt plant working at an average capacity of 60 percent. This is enough power to supply a city of 1 million people. At present, there is no econimically attractive method for storing heat for use at night and while the sun is not shining. There is also the possibility that land used for solar energy may have to be diverted from agricultural use.

Estimate of Available Energy: By the year 2000, some 20,000 megawatts of solar thermal generating capacity has been estimated. This is about 4 percent of the present electrical generating capacity of the United States.

SOLAR SEA POWER
(Ocean Thermal Energy Conversion)

Description: The biggest collector of solar energy on earth is the oceans. This fact makes possible the whole concept of ocean theramal energy conversion. Ocean thermal energy conversion uses temperature differences between surface waters and ocean depths to generate electricity. Basically, this is how ocean thermal conversion works:

1. The ocean's top layer, heated by sunlight, is relatively warm (80 degrees Fahrenheit). The lower layers (1,500 to 4,000 feet down), untouched by the sun, are cold (40 degrees Fahrenheit). A sea power plant in the ocean would draw warm water from the surface to heat a working fluid such as ammonia, propane or freon until it evaporates.
2. Pressure produced by confining the steam to a small container can rotate a turbine and thus power a generator. Cold water drawn from the depths cools the working fluid until it condenses back into a liquid and the entire cycle is repeated.

All this takes place at a power plant situated on a large floating platform. Electricity can either be sent to land through cables for conventional uses or be used to extract hydrogen from sea water. Hydrogen can be used in many ways to replace fossil fuels. Electricity could also be used to combine nitrogen from the air and hydrogen from the water to make ammonia, the primary ingredient for fertilizer.

Positive Features: Since mechanical energy can be extracted from the flow of heat energy between a hot and a cooler region, the temperature differential that exists between deep and shallow ocean water represents a constant and considerable source of energy.

Associated Problems: This process is still highly speculative. The potential for capturing this power is largely unproven because little experimentation has been done. Questions that need to be answered include: Can a design and materials be found that will resist the corrosive power of sea water? What impact on aquatic life or ocean cycles would the mixing of warm and cold water produce? Is a net energy yield possible? What are the legal and jurisdictional considerations associated with the operation of floating ocean thermal power plants? Finally, the cold water contains large amounts of dissolved carbon dioxide which would be released upon warming. What might be the long-term environmental effects of this?

Estimate of Available Energy: An ocean thermal energy demonstation plant could contribute 100 megawatts of electrical generating capacity by 1985. It is estimated that ocean thermal energy conversion could produce 20,000 megawatts or more by the year 2000. Present U.S. electrical production capacity is almost 500,000 megawatts.

CONTROLLED NUCLEAR FUSION

Description: Nuclear fusion is the process by which the sun and other stars generate their energy. It involves joining together the nuclei of two atoms, resulting in the release of energy. Normally nuclei repel each other. This is because all nuclei are positively charged, and like charges repel. However, if the nuclei can be brought very close to each other, the attractive nuclear force becomes stronger than the repelling electrical force and fusion takes place. To get the nuclei close enough, the fuel for the fusion process, heavy hydrogen, must be heated to about 100 million degrees (Celsius, Fahrenheit or Kelvin). At this temperature the nuclei are moving fast enough so that when they move together fusing conditions are met. The heated nuclei, called a plasma, are confined in a strong magnetic field often referred to as a magnetic bottle. Another method of accomplishing fusion is to embed some heavy hydrogen (deuterium) inside a small glass pellet. If the pellet is zapped with a series of powerful laser beams, the outside layer evaporates almost instantly. The counterforce generated by the rapid expansion of the outer material drives the remaining portion inward. As the material is driven inward, it is forced into a smaller volume and is heated by compression. At the high densities and temperatures generated, the fuel will fuse.

Positive Features: Fusion power has a number of significant advantages over presently contemplated energy sources. These include abundant inexpensive fuel in the form of heavy hydrogen. Because of its normal presence in all water, it is available to all countries. Fusion features lack of chemical combustion releases that contribute to air pollution and no threat of diversion of weapon materials. There is also no possibility of nuclear explosion, nuclear runaway or reactor core cooling problems.

Associated Problems: The major problem in assessing the impact of fusion is that no one knows for sure whether or not it can be accomplished regularly under controlled conditions in laboratories and power plants.

Environmental problems associated with fusion power are expected to be few. Small quantities of radioactive tritium will be released by fusion power plants. The structure inside the fusion chamber will become radioactive as a result of being bombarded by neutrons from the fusion reaction. This radioactivity will be relatively short-lived so that the structure can be refabricated for later use. The effect of high energy neutrons on metals and other materials is not well understood, and materials research is vital. It may be that the indentification and

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development of materials for the inner chamber walls and other components of the fusion reactor will be the largest technological hurdle faced by fusion scientists.

Estimated Available Energy: It is unlikely that any energy will be commercially available from fusion by the year 2000. Even if a breakthrough occurs, it will take years to move from the demonstration of feasibility to the reality of large-scale power production. However, current research timelines project the availability of some fusion power by the year 2000.

GEOTHERMAL ENERGY

Description: Geothermal energy, the natural heat of the Earth, promises to be an important source of supplemental power in selected areas around the world. While most of the Earth's heat is too diffuse to be recovered, there are concentrated pockets of heat ("hot spots") within the Earth's crust that are accessible and that could provide a significant contribution to local energy needs. If the rocks in the "hot spots" are fissured or porous and contain water, geothermal potential exists. While some of this water and steam bursts through the surface in the form of geysers or hot springs, large deposits often remain trapped below the surface and can be tapped only by drilling wells down into the porous rock. If the source that is tapped is a mixture of hot water and steam it must be piped into a power plant where the water is removed and the steam used to spin the blades in a turbine which drives a generator which produces electricity.

Positive Features: One of the strongest arguments for the increased exploitation of geothermal power is that there are few environmental problems associated with it. Geothermal power plants do not emit products of combustion that can contribute to smog. The use of geothermal energy can help stretch out our supply of oil and natural gas.

In addition to the production of electricity, it is very likely that geothermal energy will make a significant contribution to home and industrial heating. This will occur in the West and Southwest portions of the United States as the needed technology is developed.

Associated Problems: The most serious potential problem is that boron and other chemicals (which are mixed in with the geothermal water and steam) can cause damage if they are released into nearby waters or allowed to escape into the atmosphere. There is also the possibility of land subsidence resulting from the withdrawal of large amounts of water, but this could be controlled by re-injecting water into the wells. Less significant problems have to do with the odor of hydrogen sulfide (rotten egg smell) which is released during exploration and the considerable noise involved when the wells are being vented. The chemicals in the water also cause corrosion in pipes and associated equipment.

Estimated Available Energy: The more optimistic predictions concerning the energy available in the U.S. from geothermal sources amount to less than 1 percent of the total electrical generation expected by the year 2000.

WIND POWER

Description: Wind energy conversion is one of the oldest energy systems having been used for grinding grain, pumping water and producing small amounts of electricity. Today serious research is being done on both horizontal and vertical axis wind turbines. One of the more promising vertical axis turbines, called the Darrieus rotor, resembles the lower section of an eggbeater. It has curved airfoil blades so positioned that it can accept wind from any direction. One of ERDA's goals is to establish a broad technology base from which the public can select a wind unit appropriate for particular needs.

Positive Features: Wind power is cheap and non-polluting. It has features which are well adapted to farm and remote site use--eliminating the need for long and expensive transmission lines. Research continues in the effort to design larger megawatt systems for our nation's wind belt regions. The eventual large scale use of wind turbines for commercial electric power production is expected to occur through the clustering of several units into a wind energy network. The relative low environmental impact, compared to fossil and nuclear plants, has made wind power popular with environmental spokesmen.

Associated Problems: From a technological viewpoint, the major problem is the variable nature of wind energy. Wind power generators operate at their rated capacity only when the wind is blowing at or above some minimum speed. But wind speed is variable. Wind variability also has an effect on rotor revolutions per minute, which in turn influences the output frequency of the generator. Since standard U.S. power networks require constant frequency (60 cycles per second) and Alternating Current (AC), some means for regulating the frequency is needed. The storage problem must also be solved. What do you do when the wind stops blowing? Another drawback to largescale wind power development is land use. Although a single machine does not occupy much space, a giant grid of them complete with power lines would have aesthetic drawbacks. However, wind harvesting should be compatible with other uses of the land such as pasturage and farming.

Estimated Energy Available: A 1979 Solar Resource Group of the National Research Council estimated that about 50 GWe of capacity from wind energy could be installed in the U.S. This is the same capacity as all of our existing nuclear power plants.

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FUELS FROM PLANTS--BIOCONVERSION

Description: Stored chemical energy, created in plants by photosynthesis may be a promising supplemental fuel in our energy future. During photosynthesis (putting together with light) in plants, light energy is captured and used to convert water and carbon dioxide into oxygen and energy-rich plant material (carbohydrates). This energy is released when the plants or their products decay or are burned. Current efforts are directed at controlling and boosting natural photosynthesis so that crops can be produced which synthesize carbon compounds with high efficiency and produce fuels in a matter of days. The energy content of biomass is about half that of the better coals, although this varies with types of plants, availability of water, etc. On the global scale, however, photosynthesis annually stores more than ten times the amount of energy consumed by the world's population.

Positive Features: The relative abundance of arable land in the U.S, the easy convertibility of biomass into desirable liquid and gaseous fuels, and the low environmental impact of either the production or combustion of these fuels (organic materials are generally low in sulfur, for instance) have all served to stimulate interest in growing plants for energy.

Associated Problems: The strongest argument against the "plants for energy" idea is based on competition for the land. With the growing food shortages, land that can meet the nutrient and water requirements for energy farming might be better utilized for food crops. Biomass cultivation also suffers in a direct comparison with, for instance, solar collection schemes using solar cells or thermal collectors where efficiencies of 10 to 20 percent could be attained instead of the 1 to 3 percent photosynthetic efficiency. The biomass enthusiasts point out that these schemes are not mutually exclusive. Land can produce food and leftover biomass. The rubber producing guayule may grow under and around the rows of solar collectors.

Estimated Energy Available: The potential output from land used solely for the production of biomass energy sources ("energy farms") could be as high as 3.4 quads annually. Some projections indicate that biomass could provide 6 percent of our energy by 2000, up from today's level of less than 2 percent.

FUELS FROM WASTES

Description: It has been said that the wastes of society are simply resources for which we have not as yet found a use. In this view, refuse from human activities can provide a useful source of energy while simultaneously reducing some waste disposal problems. Organic material can produce methane, the main component of natural gas. In the absence of oxygen this occurs naturally, as microorganisms break down the material.

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Processes have been developed which release synthetic oil or gas from organic wastes and at the same time reclaim valuable minerals from inorganic refuse. Other processes simply allow for the burning of garbage as a supplementary fuel for power plants.

Positive Features: Fuels from wastes have the unique attraction of reclaiming energy while helping to solve the disposal problem that so many of our metropolitan areas are facing.

Associated Problems: It is difficult to separate out the various components of typical trash. The paper, the glass, the garbage and the metals are all randomly mixed together. The plants which convert trash to energy need pollution control devices, but generally their contribution to the sulfur oxide pollution in our atmosphere is lower than the fossil fuels. The energy content of trash is typically low and unpredictable. Finally, one must remember that trash, the raw material, is waste. While conversion can reclaim some of the energy, greater gains can be achieved by limiting the creation of waste in the first place.

Estimated Energy Available: Projections indicate that by the year 2010, energy retrieved from municipal and agricultural wastes could amount to 5.4 quads annually, or about 5 percent of the total projected energy use at that time.

OIL SHALE

Description: Oil shale is a sedimentary rock (marlstone) containing solid organic matter of high molecular weight called kerogen. When heated (retorted), the kerogen breaks down yielding substantial amounts of synthetic crude oil and hydrocarbon gas. The world's biggest reserves are found in the Green River formation which is located in the Rocky Mountain region of the western United States. One ton of oil shale may yield as much as 140 gallons of oil. To be of commercial interest, the yield must be approximately 25 gallons per ton or more.

Positive Features: The primary advantage of oil shale is that it is a fossil fuel. The synthetic crude that results from the heating of the shale can be refined and changed into all the products we now obtain from the refining of ordinary crude oil. Hence, no new major adjustments have to be made to use the products of oil shale development. Our present automobiles, trucks, furnaces and motors do not have to be modified. The byproducts include the raw materials for the petrochemical industry.

Associated Problems: The problems associated with oil shale development are many and large. The most talked of method for developing shale consists of digging it out of the mountain (room-and-pillar mining),

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crushing it, heating it, disposing of the large quantities of wastes in small canyons. The environmental impact includes major disruption to the land, air pollution at the refinery, the building of new towns in now remote areas and the consumption of large amounts of water in the waste disposal process. Exploitation of the oil shale reserves in our western states is projected to add over two million people to their population (mostly in Colorado and Wyoming).

One of the debates concerning oil shale development centers around the net energy question. Do you receive enough energy from the syncrude to justify the large energy expenditure that went into extracting it? Many of the problems related to oil shale development can be minimized if the shale is heated (retorted) underground (in situ). This is accomplished by drilling, fracturing the shale and then retorting the shale underground. The syncrude collects in a depression called the sump and is then pumped out. This method essentially eliminates the huge waste disposal problem and thus most of the problem of water consumption in a water poor area. Recent experience with the in situ method has shown favorable results, and combined processes are now being tried, yet much research is necessary before techniques are perfected.

Estimated Energy Available: It is estimated that the maximum limit to which an oil shale industry can develop is about 1.5 million barrels per day of production. Since the total projected energy demand for the U.S. in the year 2000 is about 100 quads per year, oil shale is capable of supplying less than two percent of our need.

TAR SANDS

Description: Tar sands are deposits of rock or sediment containing a heavey oil or tar-like fossile fuel substance too thick to be pumped to the surface by drilling. Tar sands are simply very old oil deposits from which the light hydrocarbons have escaped, leaving the heavy, asphaltic residue behind. The technology for treating tar sands to make synthetic crude oil is relatively simple, although more research on improving the technique is needed.

Positive Features: Since tar sands are hydrocarbon deposits, the raw material can be changed to a whole range of fuels--from gases to heavy furnace oils and solids. These are the fuels that our present economy runs on.

Associated Problems: Surface mining is the usual extraction method. This procedure has most of the negative impacts on the land and water of the area as coal surface mining. Waste sand left over from the processing stage must be transported back to the mining site or disposed of in some other fashion. Many of the deposits are so deep that even conventional deep mining would be too expensive. Most important, after all of the

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processing and transporting steps, it is not clear whether a net energy yield can be achieved even for the high grade ore.

Estimate of Energy Available: The largest known tar sands deposit in the world, and the only one that will be of commercial importance in the next decade, is in the Athabasca region of Alberta in western Canada. Estimates of reserves there range from more than six billion barrels of easily recoverable, high grade material, to about 300 billion barrels in total potential. Much of the tar sand can be surface mined; however, techniques for in situ (below the surface but without mining) recovery will have to be perfected to extract deep-lying deposits. In the United States, significant deposits have been discovered in Kentucky, New Mexico, Texas, and Utah. Total reserves in the U.S. are estimated to be an equivalent of 30 billion barrels (Energy Alternatives: A comparative Analysis, Council on Environmental Quality). The Energy Research and Development Administration has made only a slight commitment to tar sands.

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IT IS THE YEAR 2000

Handout #35

Scenario I

IT IS THE YEAR 2000. The earth's major source of oxygen is now seriously threatened, for the use of chemicals and other pollutants are killing off the oxygen productincg plankton in the world's oceans at an accelerated rate. It is estimated that approximately 70% of the world's oxygen is produced by plankton. Oceanographers have indicated that the world's oceans are dangerously close to ceasing to be a potential source of food supply for the world's bulging population due to accidental and intentional oil spills, pesticides and other chemical contamination, radiation waste, and other forms of pollution during the past 30 years.

Scenario II

IT IS THE YEAR 2000. Mounting evidence from research indicates that noise pollution has become a definite health hazard as serious as any other form of pollution. There is strong medical evidence which indicates that noise from jet planes, loud music, city traffic, major construction, and even household appliances appears to cause high blood pressure and heart attacks in people already suffering from existing cardiac conditions. Sonic booms may be threatening the mental stability of unborn babies. High blood pressure, heart conditions, and nervous disorders developed in normally healthy individuals, also seem to be caused by noise pollution according to results of scientific research. It has also been known for many years that people in technologically advanced and highly industrialized countries have suffered an appreciable loss of their hearing due to noise pollution.

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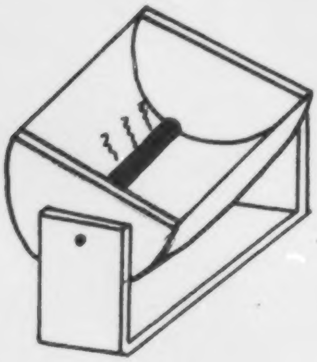
SOLAR HOT DOG COOKER

Handout #36

Option #1

Depending upon where you live, this gadget will cook a hot dog in a few minutes to half an hour. You merely point the reflector at the sun so its rays are focused upon the hot dog. You need not be a craftsman to build it. Take these plans to your local hardware store and ask a friendly clerk for help. Or maybe the school shop teacher would be willing to barter.

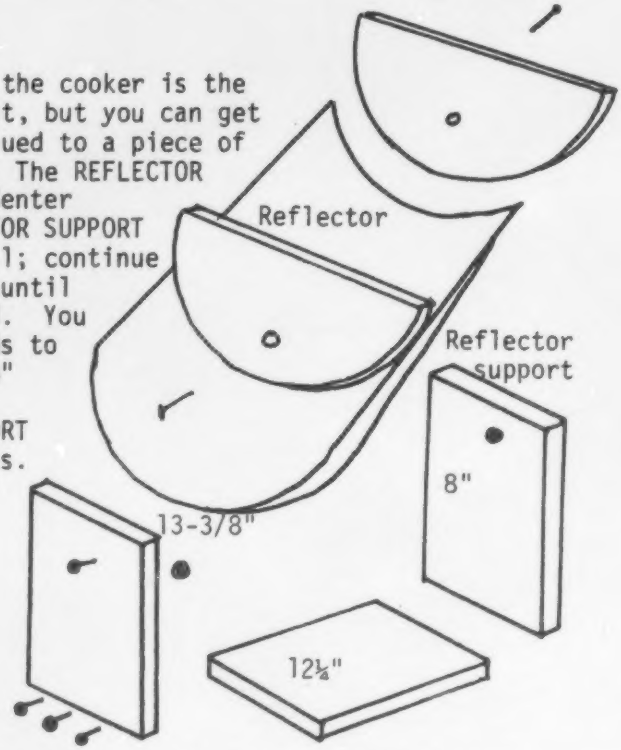


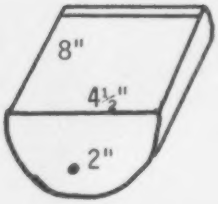
MATERIALS ***

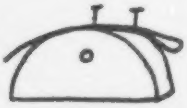
(1) BASE. 12¼" long of 1"x8" wood.
(2) SIDE SUPPORTS. 8" long of 1"x8" wood.
(2) NAILS to hold the dog. 4" long #60.
(2) ROUND-HEAD WOOD SCREWS 1-3/4" long.
(2) WASHERS for wood screws
(20-25) NAILS for reflector & base, 1" long.
(1) REFLECTOR Spectacular finish aluminum 12"x13-3/8"
(2) REFLECTOR SUPPORTS 4½" of 1"x8" wood.

DIRECTIONS ***

A critical but simple part of the cooker is the REFLECTOR. Aluminum works best, but you can get by with shiny aluminum foil glued to a piece of heavy but flexible cardboard. The REFLECTOR should be EXACTLY 12" wide. *Center REFLECTOR on REFLECTOR SUPPORT and hammer first nail; continue nailing along curve until REFLECTOR is secured. You will need three hands to do this. *Drill 1/8" diameter hole in each REFLECTOR SUPPORT to hold hot dog nails. Measure this 2" distance CAREFULLY.







Adapted with permission of the Sunshine Company, University of Colorado at Denver.

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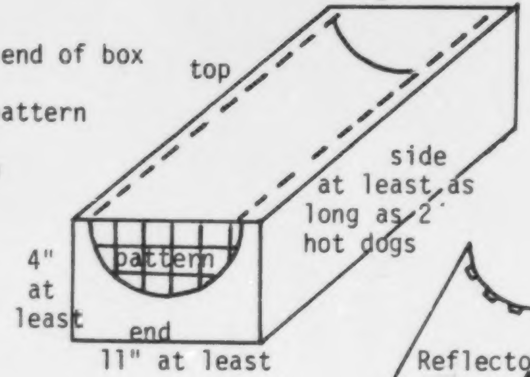
SOLAR HOT DOG COOKER

Handout #36

Option #2

The solar hot dog cooker can also be made from a fairly sturdy cardboard box. The cardboard box can be about any size as long as it is at least 11" wide and 4" deep.

Figure 1.



DIRECTIONS

1. Place parabolic pattern on end of box along top edge.
2. Trace the outside edge of pattern on both ends of box.
3. Draw lines on top of box to connect ends of the parabolic pattern. (See dotted lines on Figure 1.)
4. Cut box along these lines. Box should look like Figure 2.
5. Place reflecting material in the cavity supported at the ends of the box.
6. Tape reflecting material to box.
7. Form cut piece of box remove ends.
8. Punch a hole in the cut-off end pieces 2" from the bottom of curve. Measure this accurately.
9. Cut a slot in each piece from the straight edge to the hole. This slot allows you to put the hot dogs in the cooker.
10. Tape these ends back into their original positions on the box.
11. Point the cooker at the sun so that the shadow the cooker makes is as small as possible. The bottom of the box can be propped up with books.

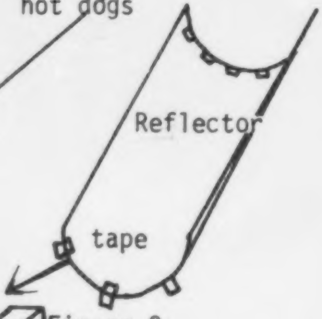
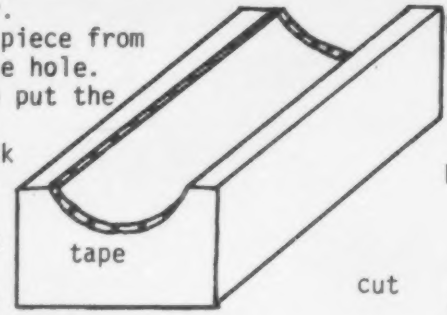
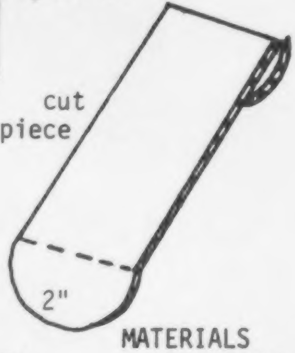
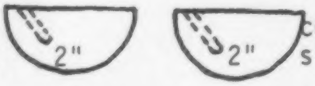
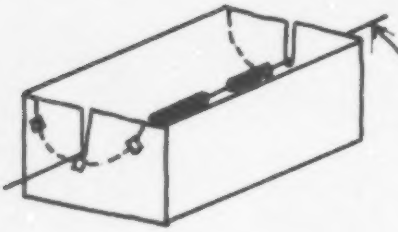


Figure 2.









MATERIALS

1. A sturdy cardboard box at least 11"x4"x10"
2. Reflector Spectular finish aluminum 13-3/8" x length of box.
3. Tape strong sticky tape like duct tape.
4. Clothes hangar--metal

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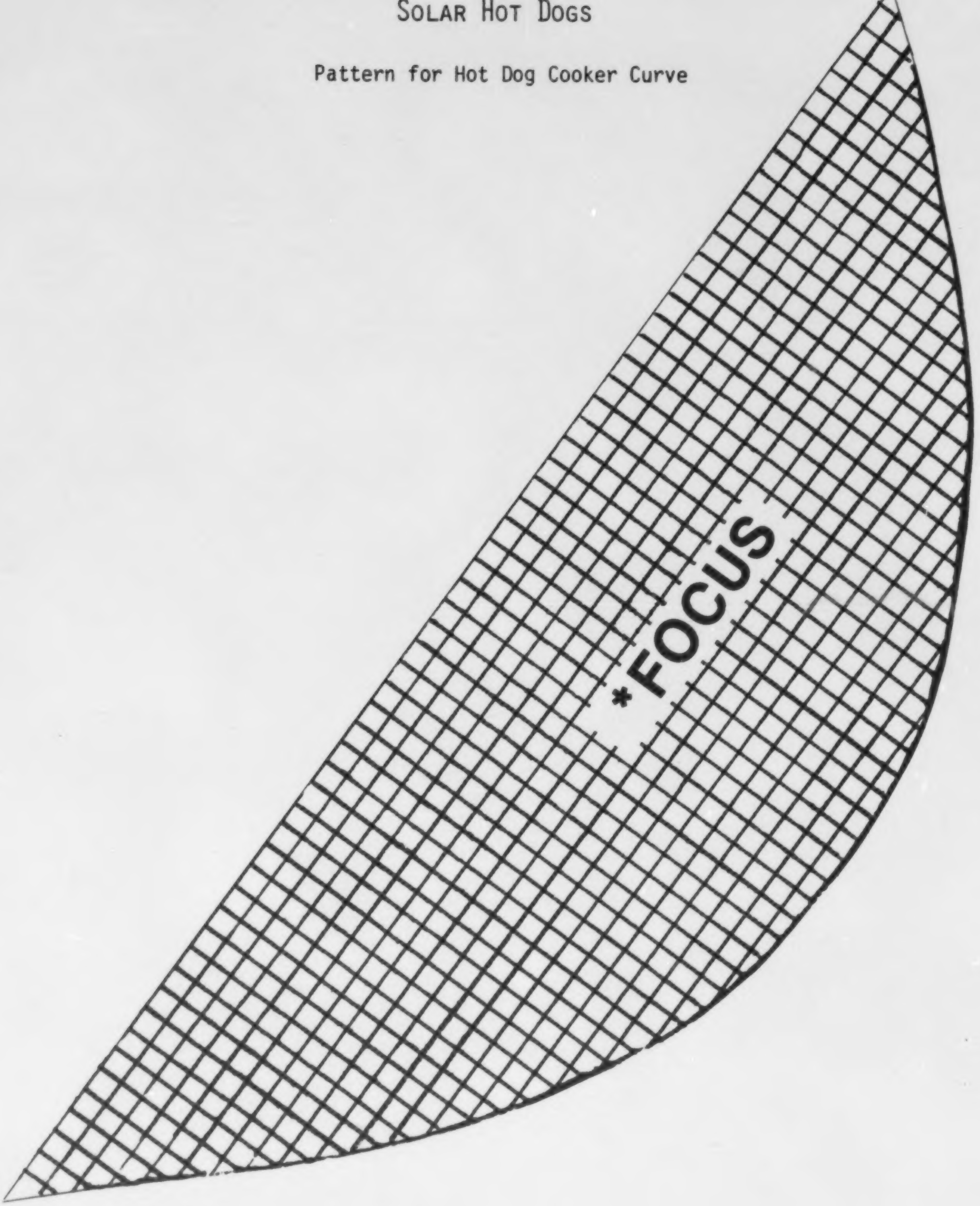
SOLAR HOT DOGS

Pattern for Hot Dog Cooker Curve



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SUNSHINE ON HIS EGGS

Handout #37

The lucky old sun used to have nothing to do but roll around heaven all day. Now David Menz has put the sun to work frying eggs. David, 16, from West Hartford, Connecticut, has invented a sun-powered cooker.

To make his solar cooker, David used packing boxes, aluminum foil, and glue. The cooker focuses the sun's rays on pans holding food--and its temperature reaches a sizzling 430 degrees F.

Current Events recently spoke with David about his solar cooker: "My grandfather didn't think my plan for a solar cooker would work. But he ate the first egg I cooked with my invention, and he said it was out of this world. I can cook almost anything with it--eggs, grilled cheese sandwiches, toast, hot dogs. Yesterday I cooked bacon for my family's Sunday breakfast. Building the cooker wasn't too complicated. But it was tough laying the sheets of foil to make a good reflecting surface. The foil tends to wrinkle. A mirror in perfect form would be more efficient. I think solar cookers will come into general use. They could be sold in kit form, using a cardboard frame and maybe parabolic curves stamped out in plastic. However, solar cookers can only be used as backup cookers. They won't work, of course, on sunless days or at night. I've just started working on a solar distiller, or water purifier. The distiller will make salt water or polluted water drinkable. I think it should have a good future. Supermarkets around here are selling distilled water. I want to help homeowners cut down on expensive energy. At the same time, there is a lot of wasted energy in the world, with the sun and wind not fully used."

That was David Menz, future king of the solar cooking industry. Pass the eggs (sunny-side up).

From Current Events (September 21, 1977).

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ENERGY-SAVING TIPS

Handout #38

HEATING

Good insulation, and in particular adequate attic insulation, is the key to reducing the energy you consume for heating. Public Service Company recommends insulating your attic to a "R-30" standard. Insulation for outer walls and floors is also important. (Insulation is also the best way to conserve energy used in air conditioning.)

Additional fuel saving steps you can take include installing storm doors and either storm windows or thermalpane glass in your windows, weather-stripping doors and windows, and caulking around windows. (Always make sure, however, that there is adequate ventilation in your home to prevent carbon monoxide and other combustion by-products from your furnace from building up inside the house.)

Choose the lowest comfortable setting for your thermostat, and do not turn it above that. Also, turning down the thermostat a few degrees overnight while you are sleeping will save fuel.

If you leave home for a few days, set the thermostat five or ten degrees lower than your normal setting.

If you have a fireplace, close the damper when it is not in use. An open damper can allow very large amounts of heat loss from your home.

Remember that warm air rises. By making sure all openings to your attic are well sealed you can prevent the escape of heat into nonliving areas.

Close the drapes over your windows at night or when it is cold outside. Heat escapes quickly through glass, and this will provide an extra layer of insulation.

Clean or change air filters in your furnace periodically so that the free flow of warm air will not be retarded. Also try to arrange furniture and drapes so that they will not interfere with the flow of heat.

Avoid excessive opening and closing of doors during the winter. Exhaust fans in bathrooms and kitchens also result in heat loss, so use them with discretion.

Have your home heating system maintained regularly by an expert.

LIGHTING

Flourescent lights produce more light for the same amount of energy and last longer than incandescent bulbs. In fact, they are two to three times more efficient, and last from seven to ten times longer than incandescent bulbs.

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The efficiency of incandescent bulbs increases as the wattage increases. That means, for example, that you get even more light from one 100-watt bulb than from two 50-watt bulbs, even though they use the same amount of energy.

Simply cleaning bulbs and fixtures regularly will help you get at least 20 percent more light.

Use low wattage bulbs for decorative purposes, and higher wattages for such tasks as reading, sewing and other sorts of close work.

And, of course, always turn lights off when they are not in use.

APPLIANCES

As a general rule, small appliances use less energy than large ones. Therefore, using a small appliance in place of a large one whenever possible conserves energy.

Do not pre-heat appliances such as stoves, frypans, irons and the like any longer than necessary; those are big energy users.

Use appliances such as washing machines, dryers and dishwashers when they have a full load. These appliances use the same amount of energy each time they are used, and doing many small loads instead of a few big ones wastes energy--and your money.

Another source of wasted energy can be easily controlled by simply taking care to turn off radios, televisions, stereos or any other kind of appliance when not being used.

Always keep filters and vents on any kind of appliance clean.

Maintain your appliances in good repair. Worn parts not only can increase energy use needlessly, they can cause excessive wear on other parts, resulting in even more costly repairs.

Do not overload electrical circuits. This results in reduced energy efficiency and also can create a safety hazard.

Read the "use and care" booklet that accompanies each appliance. Improper use of appliances can waste energy and damage them, too.

When selecting temperatures or cycles with appliances like washers, dryers and dishwashers, do not select the settings that are warmer or longer than necessary to do the job at hand.

A leak of one drop per second in a hot water tap will pour 2,500 gallons of hot water down the drain over a one year period. You pay not only for the water, but the fuel it takes to heat it.

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Showers use less energy for water heating than baths, as a rule.

Keeping your refrigerator and freezer defrosted makes them more efficient, and they will use less energy.

Keeping your refrigerator's condensor clean will make it run less frequently, keep foods properly chilled and prevent the possible burning out of the condensor.

When cooking, learn to depend on timers and thermostats instead of opening the oven door or lifting lids on pots. This only wastes heat and energy, and slows down the cooking process.

Try to plan oven meals with foods that can all be cooked at the same time. This can save a considerable amount of energy.

There are actually countless ways to save energy in the home that your own common sense will suggest. If you get into the habit of looking for ways to save energy, you will be holding down your gas and electric bill at the same time.

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INVENT A TOOL

Handout #39

Make a tool that solves a problem you have thought up.

Make something that will allow you to pick up a paperclip from the floor without bending over.

Make something that allows your voice to be heard at a great distance.

Make something with which you can see over a high fence.

Make something that makes music.

Make something with which you can inflate a paper bag without using your lungs.

Make a tool for picking up one sheet of paper at a time.

Make a tool that can be used to produce a work of art.

Make a tool that allows you to lift a penny out of a cup of water without getting your fingers wet.

Make a device that measures the distance you go while you walk.

Make a tool for picking up a grain of salt.

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QUESTIONNAIRE

Handout #40

1. "We are going to read a list of eight things that might matter to you in your life. We would like you to tell us how much each thing matters to you. Please use a scale of one to five, with one being something that matters very little to you and five being something that matters a great deal. First, we will read all eight things. Then, we will go back and repeat each one individually so you can rate it 1,2,3,4, or 5....saving energy."

No. of Responses		Very Little				Great Deal
______ 1 2 3 4 5 6 7 8 9 10	Job Security	1	2	3	4	5
______ 1 2 3 4 5 6 7 8 9 10	Family Happiness	1	2	3	4	5
______ 1 2 3 4 5 6 7 8 9 10	Saving Energy	1	2	3	4	5
______ 1 2 3 4 5 6 7 8 9 10	Preventing Crime	1	2	3	4	5
______ 1 2 3 4 5 6 7 8 9 10	Fighting Inflation	1	2	3	4	5
______ 1 2 3 4 5 6 7 8 9 10	U.S. National Security	1	2	3	4	5
______ 1 2 3 4 5 6 7 8 9 10	Preventing Pollution	1	2	3	4	5
______ 1 2 3 4 5 6 7 8 9 10	Helping Others	1	2	3	4	5

Now we would like to ask--

2. In order to save gasoline, at how slow a speed would you be willing to drive on major highways, provided everyone else had to drive at the same speed?

   49 MPH or less
   50-54 MPH
   55 MPH
   56-59 MPH
   60 MPH

   ______
   1 2 3 4 5 6 7 8 9 10

3. How willing would you be to drive a small economy car to save gasoline, provided most of the cars you drove with in traffic and on highways were also small--would you be very willing, somewhat willing, or not too willing?

   1 VERY WILLING
   2 SOMEWHAT WILLING
   3 NOT TOO WILLING
   4 DON'T DRIVE
   5 DON'T KNOW

4. In order to save heating fuel, at how low a temperature would you be willing to keep your thermostat set this winter, provided everyone else kept their homes at the same temperature?

   67 DEGREES or less
   68 DEGREES
   69 DEGREES or above
   DON'T KNOW

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5. How willing would you be to do your laundry or wash your dishes after 9:00 at night when the demand for energy is not as great as it is earlier in the day, provided everyone else did the same--would you be very willing, somewhat willing, or not too willing?

1 VERY WILLING
2 SOMEWHAT WILLING
3 NOT TOO WILLING
4 CURRENTLY WASH AT LATE HOURS
5 DON'T KNOW

6. How willing would you be to help save energy by turning down the control on your hot water heater from "hot" to "warm" provided everyone else did the same--would you be very willing, somewhat willing, or not too willing?

1 VERY WILLING
2 SOMEWHAT WILLING
3 NOT TOO WILLING
4 NO CONTROL

Now let's think about other people--

7. How likely do you think other people would be to drive at 50 miles per hour or less on major highways in order to save gasoline--do you think they would be very likely, somewhat likely, or not too likely?

1 VERY LIKELY
2 SOMEWHAT LIKELY
3 NOT TOO LIKELY
4 DON'T KNOW

8a. How likely do you think other people would be to drive small economy cars, if most people in their neighborhoods also drove small economy cars--would you say very likely, somewhat likely, or not too likely?

1 VERY LIKELY
2 SOMEWHAT LIKELY
3 NOT TOO LIKELY
4 DON'T KNOW

8b. How likely do you think other people would be to drive small economy cars in order to save gasoline, if most of the cars they drove with in traffic and on highways were also small--do you think they would be very likely, somewhat likely, or not too likely?

1 VERY LIKELY
2 SOMEWHAT LIKELY
3 NOT TOO LIKELY
4 DON'T KNOW

9. How likely do you think other people would be to keep their thermostats set at 68 degrees during the day and 60 degrees at night this winter in order to save heating fuel--do you think they would be very likely, somewhat likely, or not too likely?

1 VERY LIKELY
2 SOMEWHAT LIKELY
3 NOT TOO LIKELY
4 DON'T KNOW

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10. How likely do you think other people would be to do their laundry or wash their dishes after 9:00 at night when the energy demand is not as great as it is earlier in the day--do you think they would be very likely, somewhat likely, or not too likely?

1 VERY LIKELY
2 SOMEWHAT LIKELY
3 NOT TOO LIKELY
4 DON'T KNOW

11. How likely do you think other people would be to help save energy by turning down the controls on their hot water heaters from "hot" to "warm"--would you say very likely, somewhat likely, or not too likely?

1 VERY LIKELY
2 SOMEWHAT LIKELY
3 NOT TOO LIKELY
4 DON'T KNOW

Now, will you tell us--

12. On the average, at what speed do you drive on major highways and thruways?

Under 55 MPH
55 MPH
Over 55 MPH
Don't Know

13. Is the car you usually drive a fullsize, midsize, or economy car? (INTERVIEWER: if "DON'T KNOW" probe for--
MAKE______________ MODEL______________)

1 FULLSIZE
2 MIDSIZE
3 ECONOMY
4 DON'T DRIVE
5 DON'T KNOW

14. At what temperature do you have your home heating thermostat set now?

Under 68 degrees
68 degrees
69 - 72 degrees
Over 72 degrees

15. When are the dishes and laundry usually done in your household--in the morning, the afternoon, the evening, or late at night? (INTERVIEWER: Circle one number for dishes and one number for laundry under the appropriate columns.)

DISHES	LAUNDRY
1 MORNING	1
2 AFTERNOON	2
3 EVENING	3
4 LATE AT NIGHT	4
5 VARIES	5
6 DON'T KNOW	6

16. At what setting do you now have your hot water control?

1 HOT
2 WARM
3 OTHER (specify ____)
4 NO CONTROL
5 DON'T KNOW

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17.	Compared with other people you know, how much effort do you and your family make to save energy--would you say you make a great deal of effort, a fair amount of effort, a little effort, or no effort at all?	1 GREAT DEAL 2 FAIR AMOUNT 3 LITTLE 4 NONE 5 DON'T KNOW
18.	How much impact do you think personal conservation efforts have on total consumption of energy--would you say a great deal, a fair amount, very little, or no impact?	1 GREAT DEAL 2 FAIR AMOUNT 3 VERY LITTLE 4 NONE 5 DON'T KNOW
19.	How likely do you think it is that there will be a shortage of natural gas in your area this winter--would you say very likely, fairly likely, not very likely, or not at all likely?	1 VERY LIKELY 2 FAIRLY LIKELY 3 NOT VERY LIKELY 4 NOT AL ALL LIKELY 5 DON'T KNOW

20. Why do you say that? (The response to #19)

VERY LIKELY/FAIRLY LIKELY
__From what I have read or heard
__No real shortage/created/contrived to raise prices
__Because people have not been conserving
__Past experience/had one last year
__Low supply/unable to find new sources
__Gas is used a lot in this area
__Other answers
__Don't know

NOT VERY LIKELY/NOT AT ALL LIKELY
__Haven't heard anything about it
__No real shortage/contrived to raise prices
__Have enough in this area for winter
__Don't use much gas in this area
__Other answer
__Don't know

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NATIONAL SURVEY RESULTS

Handout #41

1.	Job Security	1-6%	2-4%	3-12%	4-15%	5-62%
	Family Happiness	1-2%	2-1%	3- 3%	4- 5%	5-89%
	Saving Energy	1-2%	2-4%	3-17%	4-21%	5-56%
	Preventing Crime	1-1%	2-2%	3- 8%	4-13%	5-76%
	Fighting Inflation	1-1%	2-3%	3-14%	4-18%	5-63%
	U.S. National Security	1-6%	2-4%	3-14%	4-19%	5-56%
	Preventing Pollution	1-3%	2-5%	3-19%	4-16%	5-56%
	Helping Others	1-2%	2-4%	3-11%	4-18%	5-64%

2.	49 MPH or less	16%
	50-54 MPH	24%
	55 MPH	47%
	56-59 MPH	0%
	60 MPH or more	11%

3.	VERY WILLING	67%
	SOMEWHAT WILLING	15%
	NOT TOO WILLING	16%
	DON'T DRIVE	
	DON'T KNOW	2%

4.	67 degrees or less	29%
	68 degrees	30%
	69 degrees or above	37%
	Don't Know	4%

5.	VERY WILLING	50%
	SOMEWHAT WILLING	22%
	NOT TOO WILLING	18%
	CURRENTLY WASH AT LATE HOURS	7%
	DON'T KNOW	3%

6.	VERY WILLING	61%
	SOMEWHAT WILLING	25%
	NOT TOO WILLING	14%
	NO CONTROL	0%

7.	VERY LIKELY	16%
	SOMEWHAT LIKELY	28%
	NOT TOO LIKELY	54%
	DON'T KNOW	2%

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8a.	VERY LIKELY	35%
	SOMEWHAT LIKELY	43%
	NOT TOO LIKELY	15%
	DON'T KNOW	7%
8b.	VERY LIKELY	35%
	SOMEWHAT LIKELY	46%
	NOT TOO LIKELY	13%
	DON'T KNOW	6%
9.	VERY LIKELY	28%
	SOMEWHAT LIKELY	40%
	NOT TOO LIKELY	29%
	DON'T KNOW	3%
10.	VERY LIKELY	18%
	SOMEWHAT LIKELY	35%
	NOT TOO LIKELY	39%
	DON'T KNOW	8%
11.	VERY LIKELY	30%
	SOMEWHAT LIKELY	42%
	NOT TOO LIKELY	25%
	DON'T KNOW	3%
12.	Under 55 MPH	26%
	55 MPH	46%
	Over 55 MPH	24%
	Don't Know	4%
13.	FULLSIZE	38%
	MIDSIZE	28%
	ECONOMY	30%
	DON'T DRIVE	
	DON'T KNOW	4%
14.	Under 68 degrees	20%
	68 degrees	18%
	69 to 72 degrees	22%
	Over 72 degrees	28%

		Dishes	Laundry
15.	MORNING	10%	40%
	AFTERNOON	7%	13%
	EVENING	37%	16%
	LATE AT NIGHT	19%	13%
	VARIES	27%	17%
	DON'T KNOW		1%

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16.	HOT	32%
	WARM	32%
	OTHER	7%
	NO CONTROL	
	DON'T KNOW	29%

17.	GREAT DEAL	33%
	FAIR AMOUNT	57%
	LITTLE	8%
	NONE	1%
	DON'T KNOW	1%

18.	GREAT DEAL	33%
	FAIR AMOUNT	41%
	LITTLE	17%
	NONE	2%
	DON'T KNOW	7%

19.	VERY LIKELY	20%
	FAIRLY LIKELY	24%
	NOT VERY LIKELY	26%
	NOT AT ALL LIKELY	16%
	DON'T KNOW	14%

20. VERY LIKELY/FAIRLY LIKELY

-From what I have read or heard	47%
-No real shortage/created/contrifed to raise prices	8%
-Because people have not been conserving	9%
-Past experience/had one last year	8%
-Low supply/unable to find new sources	4%
-Gas is used a lot in this area	4%
-Other answers	15%
-Don't know	8%

NOT VERY LIKELY/NOT AT ALL LIKELY

-Haven't heard anything about it	20%
-No real shortage/contrived to raise prices	20%
-Have enough in this area for winter	18%
-Don't use much gas in this area	11%
-Other answer	23%
-Don't know	8%

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EVALUATION QUESTIONNAIRE

The Center for Teaching International Relations is interested in receiving your comments regarding Energy Awareness. Please fill out this questionnaire and return it to the address below.

1. Which of the activities did you find most useful, and why?

2. Which of the acitivies did you find least useful, and why?

3. What suggestions do you have for improving this unit?

If you have materials on Energy Awareness that you or your school district have developed and wish us to look over and consider for publication, feel free to send us copies.

Center for Teaching International Relations
University of Denver (Colorado Seminary)
Denver, Colorado 80208

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